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MASCART'S REFLECTION ELECTROMETER.

THE numerous researches which have necessarily been made on the subject of the dielectrics employed for insulating submarine cables have brought about the invention of many instruments, one of the principal of which is Thomson's electrometer. Until the invention of that, recourse was had to electrometers possessing little sensitiveness, and the best of which was Peltier's, but all of which were entirely inadequate to the purposes of those researches to which we allude. Although this apparatus is very complicated, and exceedingly costly to construct, it has, not only for the studies of electricians but also for researches in atmospheric electricity, rendered so great services that several scientists have endeavored to simplify it in such a way as to place it more within reach, both as regards price and ease of manipulation. It was with this end in view that first M. Branly, and afterwards M. Mascart, had instruments constructed which are at present much in use, and which we think it of interest to describe in this place, since they are as yet too little known.

M. Mascart's electrometer, represented in Fig. 2, and which is being very carefully manufactured by M. Carpentier (Ruhmkorff's successor), has, for its principal part, the famous disk of four insulated sectors (styled "quadrants"), beneath which is suspended by a cotton thread an index needle formed of a thin sheet of aluminum cut into the shape of a figure 8, as seen at O, F, E (Fig. 1). We will not enter into the mathematical theory of this instrument (which is given with great completeness in M. Mascart's work on Static Electricity), but will content ourselves with pointing out its arrangement and the manner of using it.

The quadrants, A, B, C D, are, as may be seen, connected diagonally, in pairs, by silk-covered copper wires. Equal and opposite electrical charges may be communicated to these two pairs of quadrants by insulated conductors. The aluminum needle, E, F, carries above it a platinum wire, on which is fixed a small mirror, M, and which terminates in a double metallic rod, N, that dips into a glass vessel filled with concentrated sulphuric acid. Through the intermedium of a wire, P, that dips into this acid, a charge of electricity, either positive or negative, can be sent to the needle, E, F; so that the latter, in a state of rest, being placed in such a way that its axis is parallel with one of the clefts of the disk, can be actuated (when the quadrants are charged) through the influence of four concurrent forces, which cause it to swerve more or less to one side or the other, according to the manner in which the quadrants are electrized.

By means of such arrangement, in order to compare the electrical tensions or the potentials of different sources of electricity, it is only necessary to charge, in a constant manner, the two pairs of quadrants, and afterwards to put the needle in communication with each of the sources. The deviations, provided care be taken that they remain slight, are proportional to the tensions that are being studied.

The reading of the deviations is done by the aid of the little mirror, M, and an ordinary reflection scale, like that in the Thomson galvanometer. In order to obtain equal charges and opposite signs on the two pairs of sectors, they are put separately in communication with the two poles of a pile of constant current, of a certain number of elements, the middle of which is connected with the earth.

In the most recent form given this apparatus by M. Mascart, the quadrants, the needle, and the glass vessel are inclosed in a metallic cylinder, which, while protecting them from currents of air, preserves them against all external influences. This cylinder is closed at its upper part by a movable copper plate, which carries the principal parts of the apparatus, and which is kept in place by two milled screws, R, R' (Fig. 2).

The quadrants are fixed to this plate by glass rods, and one of them may be displaced by lightly pressing on the head of the screw, V. They communicate with the exterior through the two contacts, B, B', whose rods move freely through an aperture in the plate. A small collar, C, sliding with slight friction on the rod, permits of connecting it with the case or of insulating it at pleasure. It is only necessary to keep the collar raised in the position shown in the figure to insulate the contact and its corresponding quadrants, or to lower it (as shown at C' or C') to put the contact and its two quadrants in communication with the metallic case of the instrument, and consequently with the earth.

A third contact, arranged like the preceding, is in communication with the platinum rod, P, which is designed for electrizing the needle. In order that the needle may be brought to a proper position, the glass which incloses the support is governed at its lower extremity by a tangential screw, by means of which it may be turned a very minute distance at a time. By disconnecting this screw, the tube may likewise be turned by hand when it becomes necessary to cause the needle to pass rapidly over a considerable angle. Suspension is effected by means of a cotton thread, the two ends of which are tied together, and which passes through a hook at the upper part of the instrument, and through another attached to the needle. The upper hook may be raised or lowered by turning the milled head, H, to the left or right. In addition, this hook is formed of two branches that may be spread apart at will, so as to separate more or less the two points of attachment of the bifilar suspensory. A small key passing through a hole in the glass tube permits of the separation of the branches of the hook being regulated as desired. The case of the apparatus contains several apertures, such as: (1) a door, S, through which the lower surface of the sectors may be observed, and serving also for the introduction of the vessel of sulphuric acid; (2) eight rectangular openings, closed by a cylindrical glass, which allow the quadrants and needle to be seen; and (3) a lens placed in front of the mirror, designed to give better definition to the reflected image. The mirror is plane; and the platinum rod which supports it and dips into the acid is traversed at its lower end by two or three small needles lying in the same plane, which decrease the oscillations to a remarkable degree. Finally, the instrument is supported on a tripod provided with a revolving plate and leveling screw, by means of which it may be accurately leveled or changed in position with the utmost facility.

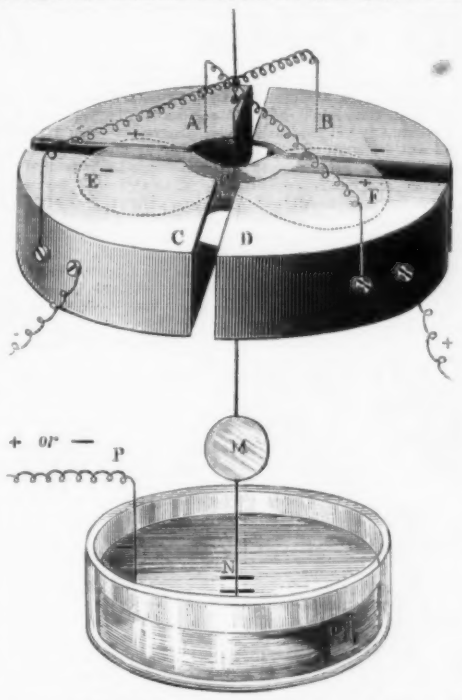


FIG. 1.—THE QUADRANTS, MIRROR, AND ACID VESSEL.

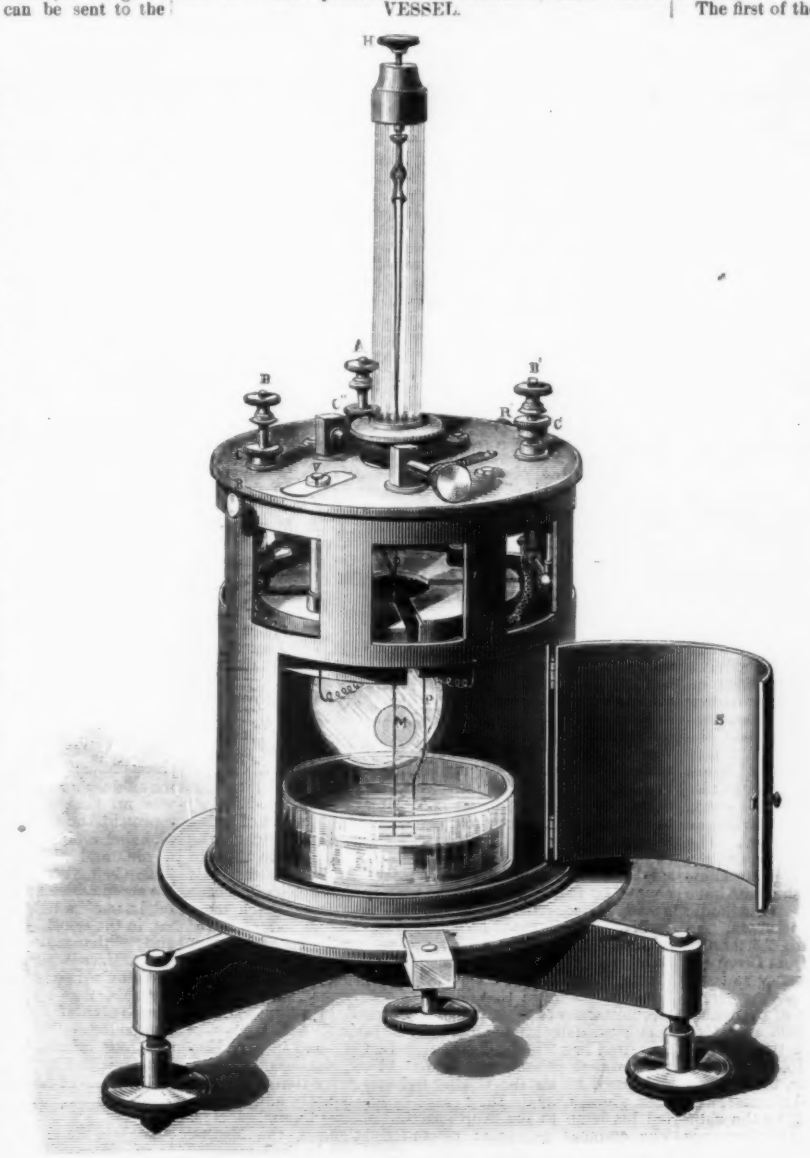


FIG. 2.—MASCART'S REFLECTION ELECTROMETER.

PRELIMINARY LABORS FOR THE RAILROAD THROUGH THE SAHARA.

THE following is a *résumé* of the contents of the reports of the four expeditions which were organized between November, 1879, and January, 1880, for the purpose of determining the possibility of constructing a railroad through the Sahara.

The first of these expeditions, viz., that under the direction of Mr. P. Soleillet, was the only one which failed to accomplish its task; the reason of the failure being that the leader placed too much confidence in the co-operation of the inhabitants of the Upper Senegal, who are mostly robbers that have rendered difficult the labors of many explorers. Mr. Soleillet left Saint Louis (Senegal) on the 16th of February, 1880, without any escort, accompanied by only a few men. He was robbed by the inhabitants on the 20th of March and forced to return to Saint Louis. Nevertheless, he was not discouraged, but has resumed the execution of his programme since June last.

The other three expeditions, having chosen a wiser basis for action, have obtained very important results.

One of them, under the direction of Mr. Choisy, government chief-engineer for the construction of bridges and roads, counted among its members an assistant engineer for the construction of roads, a mining engineer, a physician, charged with the medical and anthropological researches, and several other experts. The task of this expedition was to take observations of two different parallel regions of the Sahara of Algiers (from Laghouat to El Goléah and from Biskra to Ouargla), in order to decide through which locality the construction of a railroad was most practical.

The expedition succeeded in accomplishing: (1) a careful measurement of the stretch from Ouargla to Biskra (222 miles), which were recorded in a detailed map of measurements; (2) in measuring similarly a third part of the stretch from Laghouat to El Goléah (the whole stretch being 258 miles); (3) in measuring the more difficult parts of the road of the remaining part of the stretch (210 miles), it being impossible to use the theodolite in some places, on account of the annoyances to which the explorers were exposed, being obliged to protect themselves against the inhabitants. However, an exact itinerary was completed on this stretch; finally, proceeding toward El Goléah, the expedition ascertained that a road could easily cross the dunes near Touat (as their height at that place amounted to only 5,500 feet), made chronometric measurements, determined the exact longitude of El Goléah, and constructed a geological map of the Sahara of Algiers.

To his report Mr. Choisy has annexed a general statistic account, indicating the products of Oued-Rhir, describing the plants growing in the Sahara in regard to their scientific classification

and possible use for agriculture, and also an anthropological record.

A second expedition was charged with the task of penetrating into the country of the Touaregs.

This expedition, accompanied by experts also, was under the command of Lieutenant-Colonel Flatters, and succeeded perfectly in accomplishing its object, which was to discover, if possible, a route for a railroad by which the Soudan could be traversed without being obliged to overcome the difficult barrier presented by the Hogghar mountain. A road was found from Ouargla to a point about ninety miles south of El-Biodh, which, being free from sand, is excellently adapted for the construction of a railroad. The maps constructed by the surveyors of this expedition are excellent, and a great many special investigations regarding climate, geological condition, fertility, etc., of the country explored, add to the value of the results obtained by that expedition.

The two expeditions of Messrs. Choisy and Flatters have succeeded in discovering a route from Biskra, which, for a stretch of about six hundred miles, offers no difficulties for the construction of a railroad, contains but few dunes and hills, and is so situated that water can be easily obtained.

The labors of these two expeditions were completed by the explorations of a third expedition under the guidance of Mr. Lebiez, chief-engineer for the building of roads and bridges at Constantine. By this expedition it was ascertained that the railroad can be produced to the already constructed line from Sétif to Algiers, and that the new road running through El Biodh, Ouargla, Tuggurt, Biskra, may be extended at least to Philippeville or Bone, while its western terminus will be Algiers.

The labors of the explorers have since been resumed, though the results obtained during this summer are not yet known.

HIGH-SPEED OCEAN STEAMSHIPS.

APPARENTLY there is no limit to the demand for high speeds at sea, and all that the highest engineering skill, backed up by enormous capital, can accomplish is being done to make transit by sea rival in its rapidity transit by land. This result has been much more nearly attained than is generally believed. Roughly speaking, the distance from New York to San Francisco is about one-fourth less than that between Cork and New York. The Pacific Railway trains require a week, including stops, to cross the American continent. Such vessels as the Britannic and Germanic cross the Atlantic in very nearly the same time. The average velocities of the ship and the train are about alike, but this is due to the circumstance that the steamer never checks her progress, while the trains stop at numerous stations. It is not to be supposed that the steamers we have named are the fastest that it is possible to build. The City of Rome, it is anticipated, will make the Atlantic voyage in less time than it has yet been made; but even her performance will probably be surpassed. Rumor says that Mr. Alfred Holt, of Liverpool, proposes to add to his fleet certain Atlantic steamers which will make the trip from Liverpool to New York in a week. The passenger who goes on board in Liverpool on one Monday will be able to land at an earlier hour in New York on the following Monday. The new steamers will carry no cargo of any kind, save, perhaps, a few hundred tons of very valuable goods. They will be passenger boats and will be devoted to passengers, who will accordingly find, it is said, comforts on board, such as no existing steamer can supply. The state rooms, for example, will be of unusual size, and in many other respects these steamers will be superior to any others afloat. To do their work the ships will have to attain an average velocity in all weathers of something like twenty miles an hour, or 480 miles a day. Nor is the advent of new and fast steamships confined to the American trade. Messrs. John Elder & Co. are building for the Orient Line a couple of new steamers about 5,500 tons burden, and 7,500 indicated horse-power. Their average speed will be sixteen knots, or over eighteen miles an hour, and they will make the passage to Australia *via* the Suez Canal in thirty-two days. This will be a remarkable achievement.

How to make ocean steamships attain very high speeds is one of the most important problems ever attacked by the naval architect and the engineer. It is useless to provide engine power, however enormous, if the hull does not possess certain qualities which will enable that power to be used to the utmost advantage. Concerning this point, and the influence of form of hull on the velocity of ocean steamers, we may have something to say at another time. For the present we shall deal with other questions. Broadly speaking, it is known that the power required to propel a ship increases as the cube of the velocity; but the fuel burned on a *given voyage* varies as the square of the ship's velocity. This is a matter on which some confusion of mind exists among many persons, and it may be well to explain it. Let us suppose that a given ship makes a certain voyage at 10 knots an hour, occupies twenty days in making the voyage, and burns 10 tons of coal per day; then her entire consumption on the voyage will be $10 \times 20 = 200$ tons. If now her velocity be increased to 20 knots an hour the consumption will become 80 tons per day, but her voyage will last only ten days, and her total consumption will be 800 tons; thus her speed will be doubled, and her consumption per voyage quadrupled. It follows that in providing for the storage of coal, we may consider that the consumption augments only as the square of the speed, a most important point in favor of high speeds. Furthermore, it may be assumed that allowing for all contingencies it is not necessary to stow coal more than at the rate of 2 lb. per indicated horse power per hour. If this were not so it would be impossible to produce high speed steamers, for the simple reason that they could not carry all the fuel needed. The old type of American steamer burned about 900 tons on the voyage, making an average speed of little over 10 knots under steam; to raise her velocity to 15 knots she must have stowed over 2,000 tons of coal, for which no Atlantic steamer afloat fifteen years ago could have found room. An Atlantic steamer of the present day exerting 7,500 horse power will burn about 1,100 tons on the run from Liverpool to New York, and she can stow twice this quantity and still leave space for a couple of thousand tons of paying cargo. There is then no physical difficulty in the way of producing high speed ocean steamers, but it must be remembered that this fact is due altogether to the circumstance that marine engines can be made which burn less than 2 lb. of coal per horse power per hour. Much more, however, than economical engines is needed to obtain a successful steamer; and one of the very first points to be considered by the shipowner is the influence of size on the economic performance of a vessel. If the ship is too small she cannot attain a high speed, because she will not bear driving against a heavy head sea, and even if she could be so driven, the action of the waves in burying her would diminish her velocity, while they might leave that of a far larger ship almost unaffected. But, furthermore, if a ship be made too small, then all the available space will be occupied by coals, engines, and passengers, and there will be no room for paying cargo. Mr. Holt proposes, we understand, to use steamers for his Atlantic passenger traffic of less than 4,000 tons. By many persons this is held to be an error; but Mr. Holt is a man of very great experience in shipping matters, and not likely to make a mistake, and inasmuch as he does not want to carry cargo, but passengers only, he does not see the necessity for making his steamers as large as vessels which, like the Britannic or the Arizona, depend for much of their earnings on the carriage of cargo; Mr. Holt intends to rely altogether on passenger traffic for his profits. Whether such a speculation will or will not pay remains to be seen. We may say that a somewhat similar scheme was proposed a good while since in Liverpool; but it was contemplated to use paddle boats, and the consumption of coals was at the time about double what it is now for a given power. The speed of the proposed ships was, moreover, not to be very high—at least, it would not be regarded as high in the present day.

Reverting from the commercial to the scientific aspect of the question, there are certain facts which are not very encouraging to those who hope to see far higher speeds attained than any yet reached. The progressive speed trials carried out by some firms, and notably by Messrs. Denny, have supplied a great deal of information which was lacking before, and it is now known that although, broadly speaking, the power required to attain a given velocity varies as the cube of the velocity in theory, yet in practice it not unfrequently increases in a very much more rapid ratio, the rate of increase varying not only with the speed, but with the form of the ships. As an example we may cite H.M.S. Iris, with which elaborate progressive speed trials have been made. To drive this ship at eight knots requires 600 horse power; ten knots, 1,000 horse power; twelve knots, 1,700 horse power; fourteen knots, 2,800 horse power; sixteen knots, 4,500 horse power; and eighteen knots, 7,000 horse power. Thus to increase from eight knots to ten required 400 more horse power; but to increase from sixteen knots to eighteen costs 2,500 horse power more. "It is the last knot that runs away with the coal," is a well known engine room adage, and it is very true. Although there is, as we have said, no physical obstacle which cannot be overcome in the way of getting a speed of say twenty miles an hour, there are many obstacles in the way of getting much higher velocities. It seems to be to the last degree unlikely that any great further advance will be made in reducing the consumption of fuel in the marine engine, and were it equally certain that finality had been reached in the way of applying the power developed by a ship's engines, the chances that America would be virtually brought yet closer to this country than it is now would indeed be small. But as a matter of fact the screw propeller is an extremely imperfect apparatus, and a great deal may be done by improving it to reduce the duration of ocean voyages. Our readers will have noted what we have said concerning the Iris, and especially that 2,500 horse power was needed to raise her speed from 16 knots to 18 knots; but when the Iris was first tried 7,500 horse power only drove her at 16.5 knots, yet with different screws she attained the same speed with 5,100 horse power only. In other words, the change of screws improved her performance about 32 per cent. It seems very strange that although this fact, and others all bearing in the same direction, should be well known, their importance has been and is but slightly recognized; and even our most enterprising shipbuilders and shipowners rest content to use the same form of screw over and over again without questioning its merits or seeking for something better; and yet it is as certain as anything can be that every ship has some form of screw which is better suited to her requirements than any other. A considerable improvement in the screw propeller is the one thing wanted now to reduce the duration of ocean voyages, and the fact cannot be too strongly insisted upon by all who, like ourselves, wish the shipowner and shipbuilder success in their attempts to make ocean transport more and more speedy.—*The Engineer.*

ILLUMINATION OF LIGHTHOUSES.

A LECTURE on this subject was lately delivered by Dr. Stevenson Macadam, of Edinburgh, in connection with the Gas Exhibition at Burnbank, Glasgow. The lecturer, who was warmly received, said the illumination of lighthouses was a matter which possessed considerable general interest. Up till about a century ago common coal or wood fire was pretty much the only representative of the lighthouse, and in their primitive condition the wonder was that lighthouses could be any guide to mariners going from port to port. There were records of important lighthouses at Alexandria, Boulogne, and Dover, and these were undoubtedly simply of wood or coal fires. A century ago the question of the use of oil was barely considered. When the first Eddystone Lighthouse was erected, the only things used there were a tallow candle or two, and even when Smeaton erected the last lighthouse on the rock a number of tallow candles were still used. The use of the candles was continued till the beginning of the present century, when oil was employed instead; and in carrying out improvements in lighthouses, there is no doubt, as far as regarded Britain, that the Eddystone Lighthouse, as constructed by Smeaton, was the first representative of what they might call the modern system of lighthouse illumination. Mineral oils, up to a certain period, were always looked upon with a certain degree of suspicion, being liable, if not properly distilled, to explosion; but some ten years ago the question of using mineral oil was raised by Captain Doty, an American, who came to Europe and produced a lamp which he thought might burn paraffin oil with safety in lighthouses. Of course, by that time the lamps used in lighthouses had been greatly improved in construction, producing much more brilliant lights than hitherto; but the introduction of mineral oils formed a very important epoch in the history of lighthouse illumination. The oil used was specially made for the purpose, and was what was generally called lighthouse oil, being of that degree of safety that, under all the circumstances to which it was exposed in a lighthouse, it was practically non-explosive. Captain Doty's lamp was first used in a French lighthouse in 1868, and the late Emperor was so pleased with it that he ordered paraffin lamps to be used in all the smaller lights. After that order had been given, Captain Doty came to this country and submitted his lamp to the Northern Lighthouse Commissioners. The eminent engineers of the lighthouses, the Messrs. Stevenson, saw that there was something in the lamp, and its introduction was ordered into one of their lighthouses, the Commissioners at the same time requesting that experiments should be made in regard to its efficiency, and as to how far paraffin oil could be used. It was found that double the lighting power was obtained from the mineral oil than from the colza oil, which had hitherto been used, and that at one-half the expense, so far as the purchase of the oil was concerned. In working with a two-wick lamp, instead of getting a 40-candle power light, as formerly, the illumination was increased to about sixty-five candles, and the three-wick lamp gave the light of 160 candles. The largest lamp which was generally employed for lighthouses was what was called the four-wick lamps, and it gave us a light of about 280-candle power. In the old colza lamps, he might also state, the wicks were always liable to get a little charred, sometimes necessitating the reduction of the flame and the lowering of the light; but since the introduction of paraffin oil the wicks did not become so charred, and a wick might now be in the lamp for as long a period as six weeks; so that while the use of mineral oil had effected a great saving of expense to the public, it had also been a great saving of labor to the lighthouse keepers. In connection with this subject it might be interesting to state that after the Northern Lighthouse Commissioners had requested permission to use paraffin oil the Government had got a little afraid, on account of an accident on board a training ship in the Thames, as to the possibility of danger arising from its use in those lighthouses. He was accordingly commissioned to visit certain lighthouses where paraffin oil was used, and to make experiments as to the temperature at every point during the working of the light, the temperature of the oil at all hours of the night in the receiver, and the temperature of the overflow of the oil. The result of his experiments showed him this simple fact, that at no part of the apparatus during the actual working in the lighthouses was the oil ever raised above a temperature of 83 degrees Fahr.; and as the oil could never become inflammable until it was raised to a temperature of 140 degrees at least, they had a margin of 60 degrees of safety in using the mineral oil. Dr. Macadam went on to refer to the different kinds of lights used in order to prevent one light clashing with another; and in this connection he alluded to an apparatus to be seen in the exhibition, constructed by Mr. Peebles, to bring out an idea of Sir Wm. Thomson's that every lighthouse could flash its own name. The apparatus was worked by Morse telegraph signals. No doubt, he said, if they all learned Morse's telegraphic signals, and were always quite at home, and had plenty of time to look at the signals, the system might work quite well. But the lights which were now flashed were of a distinguishing character, and had been found amply sufficient to indicate the lighthouses. The signals by the proposed system were very complicated. For instance, to telegraph the name "Cumbrae" they required to observe 38 different signals; and, therefore, with all due deference to so eminent a physicist as Sir Wm. Thomson, he was inclined to believe that the more simple method of registering a lighthouse was either by having two lights, the one above the other, or by flashing at intervals of five or ten seconds. This mode of indicating a lighthouse was one which satisfied the want of mariners sufficiently, and at the same time did not perplex people. Passing on Dr. Macadam next spoke of the uses of reflectors and lenses, in which great improvement had been effected by the engineers of the Northern Lighthouse Commissioners; and he also referred to the introduction of dipping lights, by which a beacon on an outstanding rock from a lighthouse might be illuminated without any light being actually on it by simply throwing a reflected light on to it from the lighthouse. In regard to the use of gas in lighthouses, a large apparatus for its utilization was shown at the entrance to the hall; and wherever they could command gas in a large quantity he had no doubt the system was one which could be used with advantage. But at lighthouses where it would be requisite to prepare the gas for the purpose it was quite clear that, independent altogether of the extra work and the extra men required, there were elements of uncertainty connected with its use which required to be considered. Already the labor connected with the lamps was sufficiently trying, and he was not inclined to think that where gas required to be prepared for the lighthouse itself, in the present state of their knowledge, it ought to supersede the use of mineral oil. In conclusion, he said he thought he had brought under their notice sufficient to show that, looking at the question as they now had it, they had the history of one of the most thoroughly applied branches of physical science. The labors of many men had dovetailed into each other, and developed step by step the lighthouse of the present day, with its high power of illumination, its splendid appliances for the conservation and utilization of the light rays, and also (what they should never forget) its highly-trained and faithful body of attendants and keepers. These had all combined to give a certainty of result and, as far as they were concerned, never-failing security on their coasts.

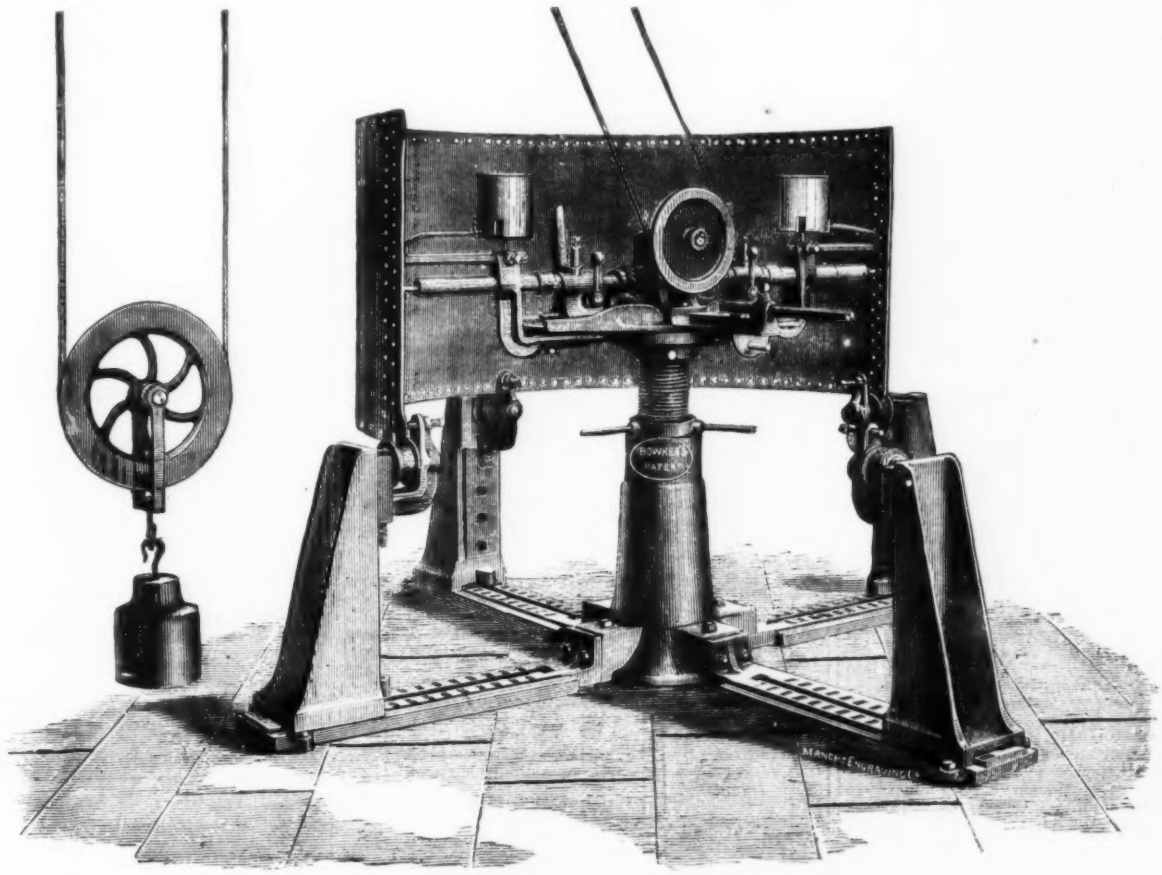
Professor Jas. Thomson said that while he listened with the greatest delight to the lecture as a whole, he wished to say a few words to correct a mistake that had been made about his brother's (Sir William Thomson) recommendation as to making of lighthouses self-discriminating. Erroneous opinions were about very much in regard to that recommendation, and his brother had written repeatedly to the Trinity Board, the *Times* newspaper, and other places, to prevent this mistake being perpetuated. It was not proposed that each lighthouse should signal out its full name, but what Sir William asked was that, for instance, three dots and a dash should represent one lighthouse, and that a dash and two dots should represent another. There was no long continuation of thirty or forty signals to represent the name of a lighthouse. One letter in Morse's alphabet would represent one lighthouse on the Firth of Clyde, and another letter would represent another, the letters being repeated at perhaps intervals of ten seconds. He should even say that the same letter of Morse's alphabet might mark a lighthouse in the Firth of Clyde, and another, say in the South of England, without any possibility of the one lighthouse being mistaken for the other.

Dr. Macadam replied that he did not wish in any way to carry on a discussion in regard to flash signals, but he might say this, that supposing the system was reduced to the simple plan of signaling a single letter, they would require for the letter "C," for instance, no fewer than four signals and four intervals. He thought the same result could be accomplished by having two lights, or by having flash lights at intervals of five or ten or thirty seconds.

OF late the electric light has been employed by naturalists to attract insects which they desire to collect for examination or to preserve as specimens.

BOILER DRILLING MACHINE.

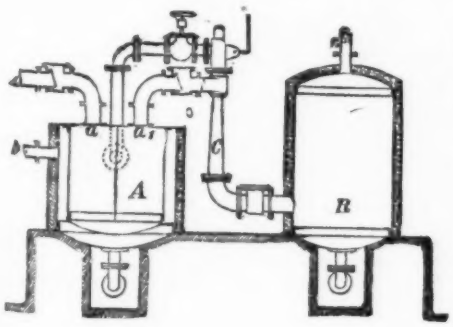
THE accompanying illustration represents a very simple, and, it is said, the cheapest, boiler shell drilling machine yet made. The use of steel plates, and the increasing favor with which high-pressure boilers are coming to be regarded by the general body of steam users, make the boiler shell drilling machine a tool which is becoming more and more indispensable in boiler-making establishments; but the type of machine hitherto in use for that purpose, being cumbersome and complicated, has been a barrier to their free introduction in consequence of the necessarily high price. This obstacle it has been the aim of the designer of the tool we illustrate to overcome. But little description of the illustration will be needed. Every turn of the nut on the screwed upright standard represents a measured rise, which determines the pitch of the vertical seams. The illustration shows only one plate for convenience of view, but in working the machine two complete rings of plates are bolted together, and the circumferential seams are drilled by two drills working opposite each other, the rings being steadied by four rods or stays set up to the plate. These stays keep the shell right, and take the thrust or spring caused by the pressure or feed of the drills, and thus prevent the drill points being broken while passing through the plates. The machine is driven by a band or rope, and the slack is taken up by an idle weight. When the driving rope gets twisted too much the shells are moved to untwist, an operation which is facilitated by the rollers on which the shell rests. The machine will drill shells from 4 ft. to 8 ft. diameter; and it is stated that two machines will keep one riveting machine in full employment. Mr. W. Bowker, of Manchester, is the inventor.—*The Engineer.*



IMPROVED BOILER SHELL DRILLING MACHINE.

SUPERHEATER, CONDENSER, AND RECEIVER FOR STEAM AND AIR.

THESE apparatus serve for the purpose of superheating steam or air having a low tension, so as to bring them to a higher tension, which is further increased by a condenser upon which these gases of high tension are conducted into a receiver, from which they may be drawn as desired. The superheater consists of a vessel, A, with double walls or of



a tubular boiler. The high pressure steam enters at *b*, and the liquid to be superheated is admitted at *a*, and at a^1 it passes into the condenser, C, constructed like an injector, and provided with an adjustable nozzle. From the injector the liquid passes into the receiver, R. The pipes conducting the liquid to be superheated to and from the superheater are provided with check valves.

THE NATIONAL MUSEUM, WASHINGTON—CLUSS & SCHULZE, ARCHITECTS.

AN abundance of most valuable material for the development of the resources of the nation, much of which dates from the gifts of foreign governments to the United States, and from the exhibit of the United States on the occasion of its Centennial International Exhibition, lying dormant and inaccessible to the public, an appropriation of $250,000 was made by Congress on March 4, 1879, for the erection of a fire-proof building for the National Museum, on the public grounds near the building of the Smithsonian Institution. The funds were to be expended under the control of the Board of Regents of the Smithsonian. The Regents created a building commission, of which Gen. Wm. T. Sherman, Dr. Parker, and Prof. S. F. Baird are the members. On invitation of this Board, Major-General M. C. Meigs consented to act as consulting engineer. On March 25th following, the commission placed the construction of the building in charge of Messrs. Cluss & Schulze, architects, the authors of the adopted designs, who are about to finish the building within the limit of the moderate amount placed at their disposal.

The building will be ready to receive the cases and a steam-heating apparatus by the month of July next. For a description of the building we quote from the official report of the architects, under date of January 1, 1880. The building starts on the ground in the form of a square with sides of 327 feet, extreme length. This is surmounted by a dome and a cross. Within its façades, a net area of 102,200 square feet, or $2\frac{5.5}{100}$ acres is covered by roofs. From one of the cellars a subterranean communication with the adjacent Smithsonian building is established, which, besides ordinary uses, will serve in cases of panic, fire, tumult, robbery, etc. On the main floor there are available, in 17 halls which freely communicate with one another, 80,300 square feet of floor space, and a proportionate amount of wall space for exhibition purposes. Further, there are available on the main floor and two upper stories of four corner pavilions and eight towers 27,400 square feet of floor-space, divided off into 135 rooms for administrative purposes, offices, working rooms, photographic studio, the necessary modern accommodations, etc. And finally, about 4,000 square feet of floor space in galleries which are intended in part for special collections, and in part to afford an unobstructed view of the *ensemble* of the exhibits.

On the whole the one story plan which has prevailed among experts ever since the Paris Exhibition of 1867, has been adopted; but by the introduction of upper stories in ornamental pavilions and towers, ample office room has been secured without encroaching materially upon the floor-space of the main halls. The center of the building is octagonal on the ground floor, and is surmounted by a sixteen-sided polygon of 67 feet diameter, which contains a tier of large windows, and constitutes a dome-like structure with a slate roof and a lantern, crowned by a decorated finial. This dome is 77 feet high on the side-walls, or 108 feet to the top of the finial. Four naves of 65 feet in width, and 117 feet in length, radiate from the dome, and extend to the outside walls of the building; these naves form a Greek cross, over the center of which the dome rises, and part of the spaces between the arms of the cross are fitted up with halls of 65 feet square, and of the same height as the naves. The side-walls of both being 42 feet high, while the height to the ridge of the slate roofs is 56 feet. These roofs are in part constructed double, for the purpose of so perfecting the drainage of the roofs that accumulations of ice and snow can nowhere obstruct it.

The spaces between the high walls of and around the Greek cross on one side, and the exterior walls of the building on the other side, are allotted mainly to eight halls of reduced height, covered by lean-to metal roofs; the extreme height of which is 32 feet. By this treatment, wall spaces are obtained for the introduction of clerestory windows, which light the square halls, and assist in lighting the naves. The four symmetrical exterior walls of the building are broken by projections in the center and at the corners, and these have been amply utilized for miscellaneous administrative purposes, as stated above. A modernized Romanesque style of architecture was adopted for the new building in order to keep a relationship with the adjacent Smithsonian building. The external architecture is based upon the general arrangement of the interior, it shows plainly the prominence of the four naves, and the careful management of the light for the central portion of the building. Four main entrances are in the centers of the façades between two lofty towers 86 feet in height; these act as buttresses for the naves. Between the towers, above and receding from the doorways, there are large arched windows set with ornamented glass, and above these the gables of the naves are formed; they contain inscription plates, and are crowned by allegorical groups of statuary.

The group over the northern gable designed by C. Buberl, of New York, already in position, introduces Columbia as the proctectress of science and industry. The second group, by the same artist, the model of which is finished, represents Peace, with the fine arts. On both sides of these prominent central features there are curtain walls. In the rear of the curtain walls, the clerestory rises to the full height of the naves, the roofs of which terminate against the side walls of the dome. The dome is treated in a similar way and strictly in the same character as the curtain wall above alluded to. In addition to the windows in the solid masonry of exterior walls, clerestory and dome, lanterns have been provided above the centers of the naves and square halls, so as to afford light for this enormous space without resorting to flat skylights.

All the masonry above ground is composed of brickwork, built hollow, for outside walls, ornamented and laid in black mortar for the facing of exterior walls. To neutralize the monotony and commonplace appearance which could not have been avoided with red brick fronts of such extent, a sufficient quantity of buff bricks has been introduced in panels and spandrels, interspersed with a small number of blue bricks in the ornamental work of brick cornices. A base course of granite extends all around the building. The wrought work of the main entrances, window sills, inscription plates, copings, etc., is of cut gray Ohio freestone. Anything else in the line of decoration is executed in substantial metal work.

The floor beams, girders, and roofs consist, or are constructed, of rolled and shaped iron. The floors are fire-proofed by brick arches and concrete. Of roofs there are no less than thirty-seven, many of them of most complicated construction. The lanterns on the ridges of the naves are large enough to cover moderate-sized dwellings. The light but solid frame work of all the roofs will be left in full view, painted in light neutral tints. The covering of the metal roofs is laid upon fire-proofed gratings, suggested by Gen. M. C. Meigs. The slates are hung to iron purlines in order to facilitate the heating of this building; the sashes all through the building are glazed with two glasses for each pane, having an intermediate air space. In all windows facing the halls, the outer pane consists of obscured glass in order to obtain a mellow light and to avoid the necessity of shades.

The floors of the main halls will consist of concrete, but the rooms and smaller halls will be floored with Florida pine laid on concrete. The interior is being plastered in sand finish, washed in tints. The wide main entrance doors of walnut and oak open outward on spacious tiled vestibules, with sides and arched ceilings of ornamented buff brickwork. These vestibules are closed after hours by wide double wrought iron gates, richly ornamented, and finished in bronze and gold. The northern entrance is intended for general use, and hence it was given due prominence. A spacious tiled platform bounded by granite side blocks in front of this entrance is approached by broad granite steps;

these are flanked by candelabra. The completion of this building, in which are inclosed 3½ million cubic feet of space above the cellars, required more than 5½ millions of bricks, 3,250 cubic yards of rubble work and concrete, 500 tons of iron, and 31,000 square feet of glass.—*American Architect.*

MAJOR MACGREGOR'S EKOWE POCKET HELIOGRAPH.

A VERY handy and portable form of heliograph has recently been designed by Major Macgregor, of the Twenty-ninth Regiment. The inventor was led to consider the subject from the success which attended his efforts to communicate, by means of sun signaling, from Fort Ekowe to the Tugela, in Zululand, last year. The means then at hand consisted only of a looking-glass, in the possession of an officer's servant, which, by suitable arrangement, did the work very well over about twenty-seven miles of country.

From Ekowe, over a distance of ten miles, Major Macgregor sent messages by means of a shaving glass, held in one hand, shutting off the sun with the skirt of his coat in the other.

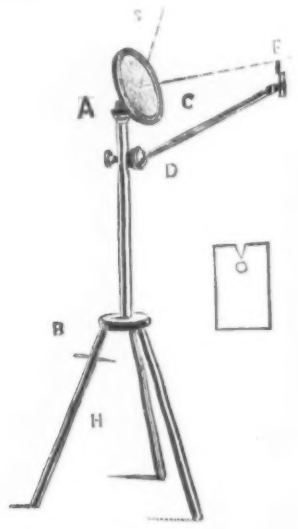


FIG. 1.

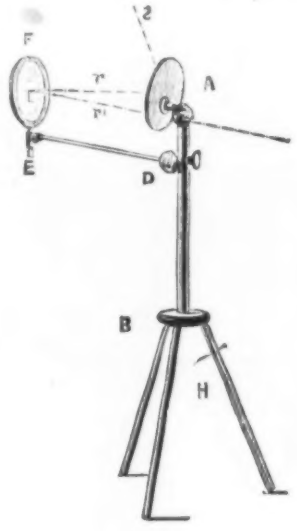


FIG. 2.

THE POCKET HELIOGRAPH.

The present instrument is extremely portable, cheap, and not liable to get out of order.

The following is a description of the apparatus:

A B is a metal stand; H, H, H, three legs screwed into base, B; A, a ball and socket, carrying a very short arm, to which is fixed a circular mirror, C, three inches diameter, having a small hole pierced through center of the backing, and the silvering removed at that point. D E is a light arm, about eight inches long, movable on a ball and socket at D, and clamped by a screw behind D.

F is a circular mirror similar to C, having a straight arm two inches long, which fits into a socket at E, the socket being movable on a hinge. The mirror, F, can be removed at pleasure, and the socket, E, turned so as to stand upright, to form a "sight vane" when the sun is in a certain position.

To pack up the instrument, the legs and mirror, C, are unscrewed. The two mirrors lie face to face, and the legs and upright of stand (with sight arm folded down) lie parallel to one another, the whole fitting into a leather case thirteen inches long, three and a half inches wide, and one and a half inches deep. The instrument weighs two pounds.

The instrument is used in the following manner:

When the sun, S, is in front—that is, toward the distant station, the heliograph is set up with the sight vane (enlarged sketch seen to the right of Fig. 1) in the general direction of the distant station, and the mirror facing in the same direction (as shown by Fig. 1).

The eye is then placed as close as convenient to the back of the mirror, and the latter looked through at the center hole; at the same the V of the sight vane, E, is set in line with the distant station.

The mirror and sight arm are then so manipulated that the dark spot, cast by the unreflecting center hole, is thrown on the bottom of the V, in the sight vane, while, *at the same time*, the center hole, bottom of V, and distant station are in one straight line. Thus, the "flash" is directed on the distant station.

Signaling is carried on by using the Morse alphabet of "dots" and "dashes," which is effected simply by interposing and removing the hand, a note book, piece of board, etc., smartly between the sight vane and the surface of the mirror. By this means letters can be sent as fast as the eye can read.

In military signaling it has recently been decided to signal by obscuration instead of by flashing, which renders this instrument rather more handy than if "flashing" only were used.

When the sun is not in the direction of the distant station, the following arrangement (shown by Fig. 2) is required. The sight vane, E, is reversed, and the second mirror, F, slipped in. The instrument is then set up so that the principal mirror, A, faces the sun, S, and has its back toward the distant station.

The center hole in mirror, A, is then looked through, and the mirrors manipulated until the reflection of distant station is seen within the V on the paper fixed on face of the mirror, F.

By a little practice the next movement can be made, which is to so manipulate the two mirrors that, by looking through the center hole of A (from behind), the distant object is seen reflected within the V of the paper on F, *and, at the same time*, the dark spot from the central unreflecting portion of A is thrown on bottom of the V on F; dots and dashes are then made as in the first case.

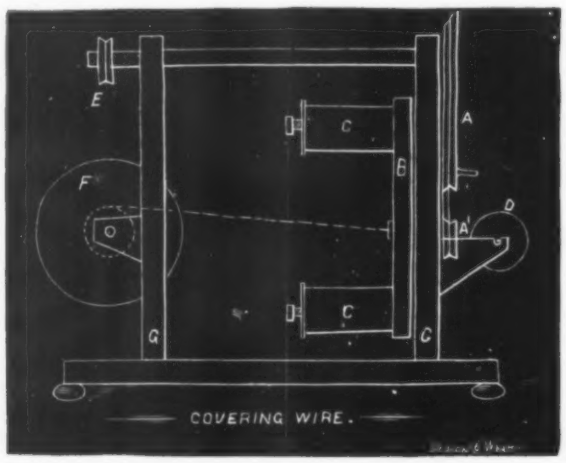
When the sun is very hot, care must be taken to clamp the sighting arm by means of the screw behind, as otherwise, the outside cap of the ball socket expands, and the arm falls.

It is necessary to slightly re-adjust the sighting, as the dark spot gradually moves from its proper position, due to the apparent motion of the sun.

The instrument, we may remark, is manufactured by Mr. Stone, of 44 Gloucester street, Bloomsbury, London.—*Telegraphic Journal.*

COVERING WIRE.

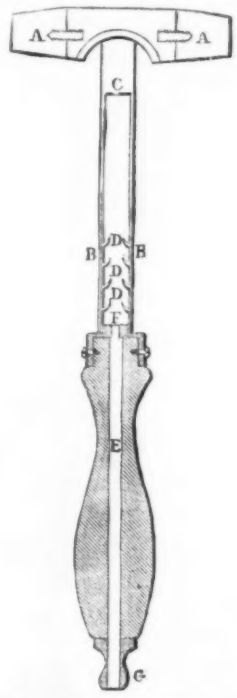
A SIMPLE yet effective machine can be constructed almost entirely of wood. The general view is shown in the sketch. Two uprights secured to a base board, as shown, carry a grooved wheel, A, actuated by the handle and the driver, A'. The latter is secured to a short hollow spindle passing through the framing, G, and on the other side is a disk, B, on which are the bobbins of cotton or silk, CC. These are



carried by the spindle down into B. At the outer end of these spindles are nuts (shown), and also a short spiral spring pressing on the bobbin ends so as to give a slight resistance, and prevent them turning round too easily. E is a small pulley on the same shaft as A, and which is connected to the wheel, F, which is carried by a bracket, as shown. The spindle of this wheel carries a bobbin also, similar to CC, but which, by means of a nut, is clamped on the spindle when in use. The action is as follows: The bobbins, CC, are placed on their pins, and a reel of uncovered wire is placed on the bracket at D. The end of this wire is carried through the hollow axis of B, and on to the empty bobbin fixed for the time to the spindle of F. On fastening the ends of the cotton or silk to the uncovered wire between the bobbin, CC, and turning the handle, the wire is slowly wound on to the bobbin at F, and of course unwound from D. As it passes, it is covered with cotton by the revolution of the bobbin, CC. The rates of speed should be something as shown, but if desired, I would furnish the proper proportions of wheels or any other particulars desired.—*Design and Work.*

GAS-HEATED SOLDERING IRON.

MOST soldering irons heated by gas require a somewhat complicated ventilator for the purpose of supplying the proper quantity of air to keep up the combustion of the gas. The result is that these instruments are so costly and complicated as to make their use limited. There are, however, several types of these apparatus which tend to completely replace those which are heated by fire. An Austrian inventor has devised an instrument of this kind, in which the necessary heat is obtained and kept up much more economically by the use of an ordinary rubber tube, the introduction of the air being regulated at will as in the Bunsen burner. By reference to the annexed cut it will be seen that the extremity carries two irons, A, A, which may be used alternately, and which are exposed to the flame. In practice one of these irons will naturally be held upright, and



GAS-HEATING SOLDERING IRON.

consequently will receive all the heat from the gas, so that the workman will always have one iron hot and ready for use as soon as the one he is using gets too cool. The irons are screwed on to the head of the tool, and may therefore be changed according to the nature of the work and the shape of the surfaces to be soldered. The burner is figured at C. It contains in its interior a number of small canals, D, D, through which air is admitted to the inside of the tube. The external orifices of these are hidden by a tube, B, which is capable of sliding in such a way as to increase or reduce the amount of air admitted. The internal gas-tube, E, may be connected at G, with a rubber tubing. At its extremity there is an aperture, F, through which the gas enters the burner and mixes with the air. The whole apparatus is very simple; and, if the person using it provides himself with a sufficient length of rubber tubing, he may execute numerous small jobs without the necessity of removing objects from their place.

ON A METHOD OF DETERMINING THE PRESSURE ON THE SOLAR SURFACE.

By PROF. E. WIEDEMANN.

IN a paper published in *Wied. Ann.* v., p. 503 (1878), I have shown how experiments on interference bands produced by two rays of light of large difference in phase may give an approximate measure of the mean free path of a molecule in a gas, or rather of the time elapsing between two encounters. I should like to draw the attention of astronomers to the fact that we may in this way obtain information as to the pressure in a luminous gas, whether in our laboratory, on the solar surface, or in the tail of a comet; for the time elapsing between two encounters of a molecule is almost independent of the temperature, and chiefly depends on the pressure.

In order to make the determination, we must decompose the light sent out by the gaseous body—say a protuberance—by means of the spectroscope, and separate a ray of light, which must be as homogeneous as possible. If we produce Newton's rings between two adjustable pieces of glass and count the number of interference bands which are visible we shall obtain the required information. In the above mentioned paper I have discussed the number of interference bands seen by J. J. Muller in a sodium flame, and shown that the result agrees well with the length of the mean free path as calculated according to the kinetic theory of gases. Various methods of producing the interference bands besides the one mentioned may of course be employed.—*Notices R. A. Soc.*

AT the meeting of the French Academy of Sciences, on Oct. 4, M. Perrier gave an interesting summary of the determinations of longitudes, latitudes, and azimuths in Africa during the years 1877 and 1878. In the exchange of signals he found it was possible to calculate the mean retardation of the transmission of a signal along an aerial conductor from chronograph to chronograph for distances between 414 and 1,236 kilometers. The mean velocity of propagation was found to be about 40,000 kilometers. At this rate an electric signal would go around the earth in a second.

THE incandescent electric light, Maxim's, is now in daily use in place of gas in the Safe Deposit Co.'s premises, Equitable Building, New York City.

SOAP-MAKING MACHINERY.

THE various operations to which toilet soap is subjected, in order to bring it into the market, may be classed under the seven following headings: (1) Slicing or dividing into thin slices the purified soap cakes extracted from the boilers; (2) pounding, or trituration of the solid masses, coloring matters, and perfumes: (3) sifting the products; (4) reducing the soap strainings into a paste, and mixture of the coloring and perfumery ingredients; (5) kneading and running out the paste in a continuous film in certain forms; (6) cutting up into cakes or squares; (7) pressing and marking the squares. These operations are at least successively carried out in the soap-making machinery constructed by Messrs. Beyer Frères, Paris, illustrations of which we now give.

The manufacture of toilet soap by this system requires the soap bars not to be more than $1\frac{1}{4}$ square inch in section. These bars are then placed in the "slicing mill," shown by Fig. 1, which slices or cuts up these bars in fine soap shav-

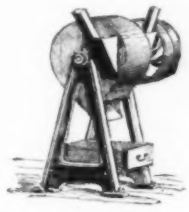


FIG. 1.

ings, so as to accelerate the desiccation and to facilitate the mixing of the coloring and scenting ingredients. The slicing mill consists of two disks, mounted on a horizontal shaft, carried on a cast iron frame. These disks are fitted with twelve blades, which cut up the bars placed in two inclined hoppers, and allow the shavings to fall into a box placed underneath the mill.

The soap now reduced into shavings is next ground or pounded in a grinding mill worked by steam, as shown in Fig. 2. The object of this operation is not merely to obtain

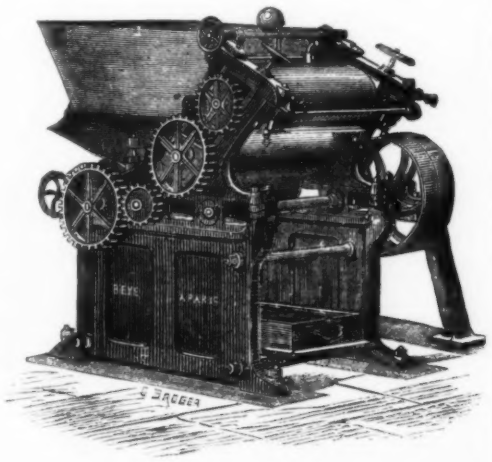


FIG. 2.

a homogeneous paste thoroughly well mixed, but also to secure an intimate combination between this paste and those coloring and scenting ingredients, etc., which it may be desired to assimilate with the soap; a soft, unctuous and well bound paste is thus obtained. This crushing mill consists of four granite cylinders, set in pairs one above the other, so that the four grind from bottom to top. After the soap shavings are charged with the scented and coloring matters, they are deposited by the attendant into a hopper, whence they are taken up between the first and second cylinders, and so ground for the first time. By a differential rotary

FIG. 3.

motion the soap arrives automatically between the second and third cylinders, and after being thus ground for the second time it is similarly passed between the third and fourth cylinders, and again crushed. This top roller is so constructed as to be able to deliver the soap paste it receives into the forementioned hopper, so that this grinding operation is repeated over and over again till the attendant, by shutting off the passage between the top roller and the hopper, forces the soapy paste to fall off the top cylinder into a box placed underneath the machine. To insure a still more perfect mixing, a comb is inserted to divide the soapy paste as it passes through the machine. Fig. 3 shows a grinding mill working with three only instead of four crushing rollers. The capacity of the machine shown in Fig. 2 is about 7 cwt. of paste per hour through the four cylinders.

The soap paste having undergone the preceding operations, may be now delivered to the machine represented by our Fig. 4. An internal endless screw forces the paste in a

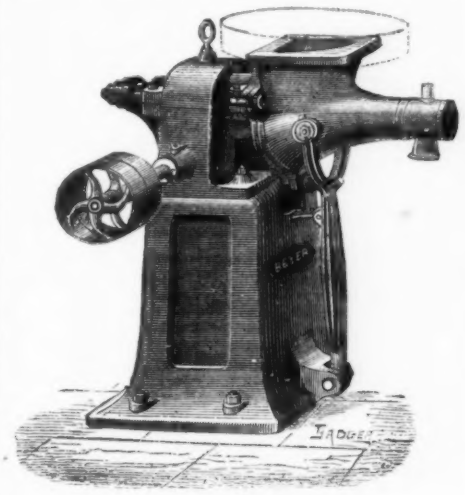


FIG. 4.

highly compressed state out of a small opening in front of the machine, and delivers the paste in a kind of endless roving or sliver, remarkable for its neat form and its lustrous polish. This machine has, however, been supplanted to some extent by the kneading mill shown in our Fig. 5. The latter, though entirely different in its construction, fulfills

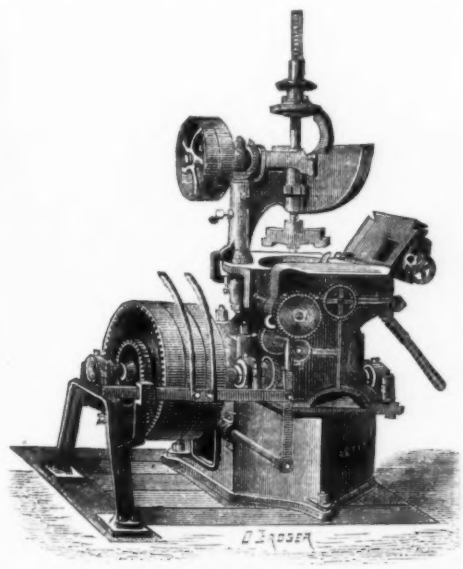


FIG. 5.

the same functions as the preceding machine, in addition to delivering the squares ready cut to any desired weight, which additional operation was formerly done by hand. It is by the aid of this last-named machine that the perfumery trade has been able to suppress many repeated and costly manipulations, often taking up five or six weeks to perform,

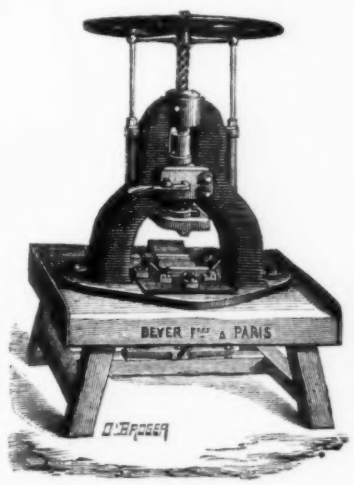


FIG. 6.

and of thus rapidly manufacturing toilet soaps in large quantities. This kneading mill consists of a mechanical pestle, which rams or beats down the soap paste into a metal cylinder. Beginning by extracting the air contained in this paste, increased pressure applied thereon forces the paste out of an opening of determined area. A knife working automatically cuts according to the size and kind of manufacture required—the paste in such a manner that each piece is exactly cut to the same size, and consequently is also of the same weight. If larger or smaller pieces are required, all that is necessary is to change the size of the outlet piece, and to alter the wheel gear working the forementioned knife.

The soap thus obtained in squares of a certain size and weight has now merely to be stamped and shaped, and this is done by the press shown in Fig 6, which illustration explains itself. It is only necessary to add that soap manufactured in this style, in a dry state, is at once ready for the market, without fear of its losing its shape or its luster. In a future article we will revert to the machinery constructed by the same firm for making ordinary household soap.—*The Engineer.*

ON THE MANUFACTURE OF SOAP IN SMALL QUANTITIES WITHOUT BOILING.

MR. W. J. MENZIES, in the course of a paper on the above subject, printed in the *Chemist and Druggist*, of Aug. 4, gives the following practical recipe:

Take exactly 10 lb. of double refined 98 per cent. caustic soda powder (Greenbank), put it in any can or jar with 45 lb. ($4\frac{1}{2}$ gallons) of water, stir it once or twice, when it will dissolve immediately and become quite hot; let it stand until the lye thus made is cold. Weigh out and place in any convenient vessel for mixing, exactly 75 lb. of clean grease, tallow, or oil (*not* mineral oil). If grease or tallow be used, melt it slowly over the fire until it is liquid and *just warm*—say, temperature not over 100° F. If oil be used, no heating is required. Pour the lye slowly into the melted grease or oil in a small stream continuously, at the same time stirring with a flat wooden stirrer about three inches broad; continue gently stirring until the lye and grease are thoroughly combined and in appearance like honey. Do not stir too long, or the mixture will separate itself again. The time required varies somewhat with the weather and the kind of tallow, grease, or oil used; from fifteen to twenty minutes will be enough. When the mixing is completed, pour off the liquid soap into any old square box for a mould sufficiently large to hold it, previously dampening the sides with water so as to prevent the soap sticking. Wrap up the box well with old blankets, or, better still, put it in a warm place until the next day, when the box will contain a block of 130 lb. of soap, which can afterwards be cut up with a wire. Remember the chief points in the above directions, which must be exactly followed. The lye must be allowed to *cool*. If melted tallow or grease be used, it must not be more than *warm*. The *exact* weights of double refined 98 per cent. powdered caustic soda and tallow or oil must be taken; also the lye must be stirred into the grease, *not* grease or oil added to the lye. If the grease or tallow used be not clean or *contains salt* it must be "rendered," or purified, previous to use, that is to say, boiled with water, and allowed to become hard again to throw out the impurities. Any salt present will spoil the whole operation entirely, but discolored or rancid grease or tallow is just as good as fresh for soap making purposes.

If the soap turn out streaky and uneven it has not been thoroughly mixed. If very sharp to the taste, too much soda has been taken. If soft, mild, and greasy, too little soda has been used. In either case it must now be thrown into a pan, and brought to a boil with a little more water. In the first case boiling is all that is necessary; in the other instances a very little oil or a very little more of the double refined powdered caustic soda must be added to the water. These things will never happen, however, if the directions are exactly followed, and after the soap has been made several times with the experience thus gained, the process is extremely easy, and the result will be always a good batch of soap. Beef tallow makes the hardest soap, mutton fat a rather softer soap; of oils, cotton seed is the cheapest and best, but the soap is much softer, lathering very freely indeed. Ordinary household fat or dripping will make a nice soap, and in many places can be obtained at a very trifling cost, and in exchange for goods sold. Such grease, however, must be carefully examined for *salt*, which it often contains. It will be evident that any smaller quantity of soap can be made at a time, according to the above directions, by taking the ingredients in exact proportion. It is not advisable to make more than double the quantity prescribed, as it is difficult to work more by hand. By making successive batches, however, a single person can make two tons of soap in a day simply with apparatus (pans, etc.) obtainable in any household.

By adding a few drops of essential oil just when the mixing is completed a toilet soap is produced. Oil of mirbane (artificial almond oil) is the cheapest, but the perfume is not nearly so pleasant as real almond oil, citronella, or oil of cloves. If made with clean grease or tallow or light colored oil, the soap produced is quite white.

Sometimes a little coloring matter will make the soap *sell* better, although of no better quality. Half an ounce of bichromate of potash dissolved in the *lye* will give a green; 1 lb. of palm oil melted with the tallow or oil, a yellow color; or a good brown can be got by burning $\frac{1}{2}$ lb. of sugar in a saucepan until black, then dissolving it in a pint of water, and adding it to the melted tallow before mixing.

A *very cheap* and good jelly soft soap can be made with the above soap. Take 5 lb. of the hard soap, crush it down or cut it up into as small pieces as possible; put this into a pan or boiler with ten gallons of water if a strong hard tallow soap; if an oil soap only half the quantity of water (five gallons); just bring it to a boil, and stir well, to thoroughly dissolve all the pieces of hard soap; pour or ladle it into any can, tub, or barrel that is tight, and leave it to cool for two or three days. This will give about 80 lb. of jelly soft soap, at an exceedingly small cost. Of course, if made from colored and scented hard soap it will be a colored and scented jelly soap. This is a good way of working up the scraps and bits of soap after cutting up. It can be sold with a good profit at a very low figure, and often as a substitute for regular soft soap. It is a *very different* article, however, to a *real* potash soft soap, which should invariably be used for washing woolens. It is possible to produce this real potash soft soap in the cold by a somewhat similar process to the above.

M. IZARD recommends the following plan of stripping photographic films from glass. Make a solution of rubber in benzol, and coat your negative with it; when dry, apply a film of collodion, yet another of rubber, and finally, another of collodion. A narrow strip of black paper is then cemented to the margin of the plate all round, and this, when the film is dry and is stripped with a penknife, makes a suitable frame.

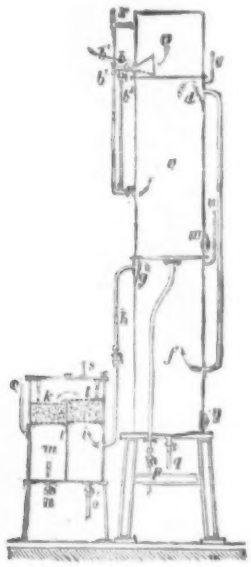
APPARATUS FOR CLEANSING OIL.

THE question, How can the waste oil which is used for oiling machinery be cleansed? has been spoken of lately in several of our technical journals, and we call the attention of our readers to an apparatus by which this has been successfully accomplished

The inventor is A. Koellner, of Kiel. It has been demonstrated experimentally that 50 per cent of oil may be saved by the use of this apparatus. The oil may be used in great quantity in oiling the machinery, which will prevent the latter from wearing out, and the oil can be cleansed at small expense.

Our figure shows the apparatus in $\frac{1}{10}$ of its natural size. Its construction is as follows:

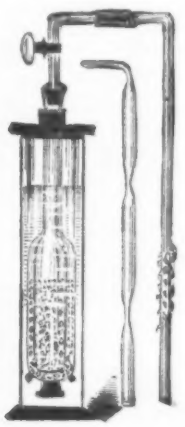
The dirty oil is put into the vessel, *a*, and runs slowly through the pipe, *b*, into the partition, *c*. The flowing oil may be observed through the glass tube, *b*¹. In the partition, *c*, which must have a sufficient size, the dirt is deposited, while the clean oil rises upward, and finally enters through the tube, *e*, into the partition, *f*. In the latter, which has the same construction as *c*, may be deposited any remaining dirt. From *f*, the oil runs over the partition, *g*, through the pipe, *h*, into the partition, *i*. In *i*, there are



two boxes, *k* and *l*, which are filled with clean white batting; these boxes are separated from each other by the partition wall, *l*, through which the oil passes once downward and once upward. Finally when the oil is perfectly cleansed, it is collected in *m*, and is let off through the tap, *n*. The dirt which has been deposited in the different partitions can be let off through the taps, *o*, *p*, and *q*. The tubes, *r*, *s*, *u*, *v*, and *x*, are air pipes for the different partitions. The cleansing will be done quicker and with better advantage if the apparatus is slightly warmed (from 77° to 115° F.). Therefore, the apparatus is connected with a steam tube which has the diameter of about $\frac{5}{8}$ of an inch. The consumption of steam which is condensed in the apparatus is very small, as it is only necessary to admit it from time to time. It may even be dispensed with if the apparatus is placed in a warm room. The apparatus shown in our illustration furnishes every day about 60 lb. of pure oil. Usually in the oil used for machinery there is 10 per cent. of dirt, and 90 per cent. of pure oil which may be used again. The refuse or dirt is only removed once a month, and the refilling with cotton is done about as often.

APPARATUS FOR SULPHURETED HYDROGEN.

MOST of the apparatus used for the development of sulphureted hydrogen are only practical if continually in use, and the only one which may be otherwise employed, that of Kipp & Mohr, is too expensive. Mr. Max Kähler, Berlin W., Wilhelmstrasse 50, has constructed an apparatus which may be easily put together and cleaned, and after



it is used may be left at rest for an indifferent length of time without needing any revision for further use. Its parts are so completely fitted into each other that it is impossible for the gas to escape.

This new apparatus, which is constructed in the fashion of Döbereiner's platina lighter, consists of a cylinder having a height of at least 7 inches and a breadth of from 2 to 3 inches, in which a bell shaped vessel is suspended, serving for the reception of sulphurous iron. This vessel reaches down to about 0·6 inch from the bottom, and its neck is connected with a perfectly fitting glass tap, which can at any time be easily removed and put back. The bell itself, which has outlet openings at the bottom, is suspended from a wooden cover which closes the cylinder. A layer having the thickness of 0·5 inch, consisting of coarse gravel or small fragments of porcelain or glass, is put into the bell-vessel, and on top of this there is placed sulphurous iron in pieces having about the size of a pea. Finally, so much diluted sulphuric acid is poured into the cylinder that when the tap is closed and the bell-vessel immersed the cylinder is filled nearly to the brim. When the top is opened the sulphuric acid enters the bell-vessel and the development of gas at once begins, but after the tap is closed, this development continues only until the sulphuric acid is forced out. By the isolating layer of gravel any direct contact between the acid and the iron is avoided, and an accidental development of gas cannot take place. In order to use the apparatus again it is only necessary to open the tap. If, by a formation of crystals of sulphate of iron, the outlet openings should be filled up, it will be sufficient to place the bell-vessel, which can be easily taken out, for a few minutes in warm water.

Mr. Kähler's apparatus is well adapted for the use of laboratories, and if connected with a suitable outlet tube can be used for the detection of arsenic.

DEVELOPMENT OF GELATINE PLATES.

By W. T. WILKINSON.

My own experience, working the gelatine process side by side with wet collodion, and by a careful and wide examination of the work of others in gelatine, has confirmed the belief (or certainty) that even leaving quick exposures out of question, as good results can be got on gelatine as by the wet process, even when working it in its most sensitive and favorable condition, so that when the immense advantage of shorter exposure is considered and allowed its full value, not the slightest doubt exists, that for commercial photography, the gelatine process is the best; but (and there is a "but") to get the highest quality of result from gelatine it is in the highest degree necessary that careful and intelligent manipulation be resorted to, remembering, when examining the beautiful thin negative, that what gelatine lacks in visual thickness it makes up for in non-actinic vigor, and also that it is a process of only about three years' (general) use, and is constantly being improved both in quality of result and ease of working, while the wet collodion is thirty years old, and is practically in the same condition as when first introduced, proof of which can be seen by a perusal of my paper read before the South London Society in 1876, entitled "Archer's Process."

This being so, it now remains to consider the best means of working gelatine plates so as to get the best results possible.

We will begin with the ferrous oxalate developer; after a long series of experiments, under every conceivable condition, I am obliged to come to the conclusion that in no case can the best results possible be got that the gelatine plate is capable of giving when ferrous oxalate is used as the developer of the latent image. This conclusion has not been arrived at hastily, but after careful comparative experiment, the gravest fault being the impossibility of getting detail in the high lights, especially discernible when masses of white drapery have to be rendered.*

Ferrous oxalate being wanting, we will proceed to consider the best method of using the alkaline pyrogallic.

A careful perusal of the instructions sent out by the different makers for use with their plates exhibits a considerable amount of ingenuity in framing a developing solution that shall be (apparently) different from that recommended by a rival; but when reduced to paper, side by side, it will be found that practically all are very nearly alike.

Some makers aver that pyrogallic is best kept in a dry state, and dissolved as required, recommending the operator either to weigh out in small quantities, or to guess the amount for each plate. Both these plans are bad in principle: in the first instance, pyrogallic is difficult to weigh out in small quantities with any degree of certainty; and in the next place, by no amount of practice can the proper amount be guessed to give absolute certainty; besides which, a bottle of pyrogallic once opened deteriorates as rapidly dry as in aqueous solution, while there is the chance of introducing dirt when opening in the dark room.

Leaving the pyrogallic, we will consider the restrainer and accelerator. Some makers direct the mixture of ammonia and bromide to be used in drops, others in much larger quantities. The dropping plan is very uncertain, as by such a very little over, the plate is ruined.

Careful consideration of the above points is fully met by the formula published by Mr. B. J. Edwards. This formula is suited for all kinds of gelatine plates. The pyrogallic keeps well; in fact, I have some now, three months old, which gives as good a negative as a freshly prepared solution. There is all the requisite latitude, besides absolute certainty as to result.

To prevent confusion, it will, perhaps, be as well to give the original formula, which stands thus:

Solution No. 1.

Pyrogallic acid	1 ounce.
Glycerine	1 "
Spirits of wine (methylated)	6 ounces.

Solution No. 2.

Liquor ammonia 0·880	1 ounce.
Bromide ammonia or potassium	60 grains.
Glycerine	1 ounce.
Water	6 ounces.

Solution D (developer).

Solution No. 1	1 ounce.
Water	15 ounces.

Solution A (accelerator).

Solution No. 2	1 ounce.
Water	15 ounces.

To use for a properly exposed plate, take equal parts of each solution D and A. In solutions Nos. 1 and 2, white sugar or honey may be substituted for the glycerine.

The proportions given above for a properly exposed plate leave nothing to be desired, unless the plate be apt to give thin flat images, in which case solution D will be best compounded of

No. 1	2 ounces.
Water	14 "

A still being the same. On the contrary, when the density is likely to be too much, as little as half an ounce of No. 1 to 15½ of water may be used. By thus modifying the pyrogallic solution, any desired degree of density may be obtained, and, as to the exposure, the solution is regulated in the same manner by using less or more as the exposure has been long or short.

To develop a plate, the exposure of which it is anticipated has been far too much or is very uncertain, it is best laid in a dish and covered with the requisite quantity of pyrogallic solution mixed for a weak plate with (say) two ounces of solution; now add one drachm of solution A, and allow to act for a minute or two, repeating the dose until the image begins to appear. When the image begins to appear, the dish may be covered up and left for five or ten minutes, when, on examination, a good negative will be the result. A more elaborate method, and, perhaps, more reliable, is to make up solution No. 2 in two solutions, keeping the ammonia and bromide separate, diluting the concentrated solutions as usual with water, and then going cautiously to work, adding the full quantity of bromide to the pyrogallic, but only adding sufficient of the dilute ammonia to start the action, then leaving the result to time. Under exposed plates can be managed by a reversal of the above method, using solution D weak, as directed for dense plates, and using double the amount of ammonia solution to bromide, but always in a dilute state. Do not be in a hurry; give the plate time; and, if you are impatient, cover up the dish and go away for a time—on your return you will see a far better result than if you had tried to hurry the process.

To develop a picture, containing violent contrasts, mix equal parts of D and A, and add five times the bulk of water; place the plate in, and give about half an hour to an hour to be finished in.

After the image has been properly developed, the next stage is to well wash it back and front, and then immerse in a tolerably strong solution of alum. The functions of this solution are twofold: first, as a guard against frilling in the subsequent washing, and also to clear out of the film the remaining pyrogallic from the developer, and avoid red stained shadows. The time of immersion is immaterial, so long as no less than three minutes are allowed. After again washing, the plate is removed to the hyposulphite for fixing; the strength of the hyposulphite is rather important, as if too strong, the film will frill; and if too weak, the time of immersion is too long; about half saturation is the best strength. If any tendency to frill be suspected, the plate ought to be immersed in a solution of chrome alum upon leaving the hyposulphite bath; after this, wash thoroughly under the tap, and then place in a grooved tin box containing clean water, which ought to be constantly changed for three or four hours. Now if, after rinsing, a weak solution of cyanide be flowed over the film, and well washed off, the image can be easily and readily intensified by means of pyrogallic and silver.

Some photographers complain of the difficulty of getting sufficient density in their negatives; but, if care be used, and attention paid to the strength of the developer used after developing the first of a batch, little or no trouble ought to be experienced in getting just the proper amount of density. If, however, as may sometimes happen, the negative is not dense enough, if only a little be required, pyrogallic and silver will give it; but if the lack of density be considerable, then Edwards' formula for mercury intensifier is the very best that can be used. Do not on any account (except for copies of drawings, etc.) use the plan of bleaching with mercury, and then blackening with ammonia, as there is so little latitude that the best result is difficult to attain with the mixed mercury, potassium, and hyposulphite solution. The color of the negative after immersion is so near the old collodion color that it is easily managed, and, if not used too strong, is perfectly under control.

With careful manipulation a gelatine negative need never be stained; but as it sometimes happens that they do get stained, especially in intensifying, it will be as well to mention that one of the first remedies that ought to be tried, and which, in most cases, will be found efficacious, is immersion in fresh hyposulphite. A weak solution of hydrochloric acid in alum water will also remove stains. Weak solution of cyanide in alum water will remove silver stains contracted from sensitive paper. The most obstinate stains can be removed by using a mixture of common salt and sulphuric acid, as directed by a formula published in the *News* a short time back.

When this paper was projected, I intended to give some account of the characteristics of different makers' plates, and with that intention procured from various sources, half plates by Wratten and Wainwright, Rouch, Mawdsley, Swan, Fry, the Britannia, Archer, and Bennett. Each plate was exposed in the studio as rapidly as possible, two cartes on each; but the result was that all plates in the market will give good negatives, providing care be taken to use them intelligently, and if a fresh batch does not give the same results with the same developer as a previous one, alter the developer to suit.

In conclusion, I might mention that it is not necessary to use a fresh lot of developer for each plate, but that four ounces will develop at least six plates, when done one after the other; also, that overdense negatives can be reduced by a weak solution of perchloride of iron, followed, after thorough washing, with hyposulphite; or else the negative may be bleached by immersion in a solution of bichloride of mercury.—*Photographic News.*

* This, it must be remembered, is but the personal opinion of the writer. —ED. P. N.

THE FUTURE OF AMERICAN COTTON MANUFACTURE.—THE POSSIBILITIES OF SOUTHERN WATER POWER.

IN a communication from Atlanta, Ga., dated October 31, Mr. Henry N. Meigs writes as follows to the New York *Herald:*

There are now some 10,000,000 cotton spindles operated in the Union. In the year 1900, only nineteen years away, there will be 20,000,000 needed, because the increase of population and of exportation of American goods will demand them. The population, as ascertained by the recent census, is, in round numbers, 50,000,000. In 1870 it was 38,000,000—an increase of thirty-one and a half per cent. in ten years. The same rate of increase for the next two decades will make it 86,000,000. To sustain this estimate let me suggest that from 1790 to 1820 and for each succeeding period of thirty years the "Compendium United States Census" shows an average increase of over one hundred and forty per cent. This ratio applied to the 38,000,000 of 1870 gives us over 90,000,000 in 1900—thirty years later. So it appears that twenty years hence we may expect a population nearly double that of the present year as just ascertained. Even if this estimate of population fails the increased tendency of the people toward manufactures will compen-

sate for the smaller number of the population. Will not two pounds of cotton goods be required from United States mills in 1900 for one pound now produced? If this is correct 20,000,000 of spindles will be required.

During the interval of nineteen years most of the spindles now in use will be worn out or otherwise destroyed. Let us say that 5,000,000 must be replaced and 10,000,000 more must be supplied—in all 15,000,000, with all their preparatory and following machinery—before the end of this century. Is this extravagant? I think not. One-half of the 7,000,000 at work in 1870 were operated by steam, the other half by water power. The *Financial Chronicle* reports the home consumption last year at 1,800,000 bales, averaging 481 pounds each. This is equivalent to over 865,000,000 pounds. If the ratio of 1870 has been maintained some 430,000,000 pounds have been manufactured by steam in 1879 and 1880. Is this economical? It pays, certainly; but does it pay as well as with water power? The requisite power for 1,000 spindles, with looms, has been variously estimated at fifteen to twenty-five horse power. As all speeds have been accelerated since the introduction of the American ring spindle, let us take (in medio) the ratio of twenty horse power. For 20,000,000 of spindles, with looms, this ratio demands 400,000 horse power.

COUNTING THE COST.

The steam engines of the country will average, I suppose, a consumption of six pounds of coal per horse power per hour or 60 pounds per day of ten hours' work. At this rate there will be required 24,000,000 pounds of coal daily, or 12,000 tons, to do the amount of duty required. I suppose the average cost of coal will be $4, to cover prime cost, freight, dravage, labor, and storage. Here we have a charge for steam fuel alone of $48,000 per day, and for a working year of 312 days of $15,000,000. Add to this the wages of engineers, firemen, and laborers to handle the coal; the excess of repair; cost of engines over that of turbines; the excess of oil required (a few gills daily are sufficient for a turbine of 100 horse power making eighty revolutions per minute); the greater cost of engines; the unavoidable outlay for engine and boiler houses and stacks, and the somewhat increased danger of fire, and it seems that $15,000,000 is a low estimate of the annual cost of steam power for 20,000,000 of spindles with looms. What would be the cost with water power?

The city of Augusta, Ga., has built a magnificent canal, which furnishes now 12,000 horse power, with capacity of great increase, at the annual charge of $5 50 per horse power, or 1½ cents per horse power per day. One hundred horse power on this canal will cost a manufacturer $550 per annum. This is a splendid climate, with cheap building materials, abundant and cheap labor, teachable, tractable, thankful for employment, and utterly unacquainted with "strikes" and State taxation—three-tenths of one per cent—to be reduced rather than increased, for the State finances, are in a most satisfactory condition. Georgia has floated four per cent bonds at par, a financial feat, I believe, not paralleled by any other State. Manufactures are firmly established there and very remunerative. Stocks are far above par. At the water rent fixed by the city of Augusta the 400,000 horse power estimated would cost $2,200,000 instead of $15,000,000 by steam, a saving of nearly $13,000,000 annually, and of $250,000,000 in twenty years. If these estimates are even approximately correct there can be no doubt of the greatly superior economy of water over steam power.

RESOURCES OF THE SOUTH.

Water power abounds in North and South Carolina, Virginia, Georgia, and Alabama, and is to be found in other Southern States. At Augusta the supply can be doubled when needed. At Macon a similar canal is practicable which can furnish an immense power. Near Columbia, S. C., is a magnificent power. At Athens, Ga., and in its immediate vicinity there are numerous falls of great capacity. At Tallassee and at other points in Alabama the falls are very fine. The Chattahoochee River, in this State, falls 112 feet in a distance of twelve miles, with the successful manufacturing city of Columbus at the lower end of the falls. Here are the celebrated Eagle and Phœnix mills, a pride to the city, to the State, and to the Union. The river, rising far away among the mountains of Upper Georgia, affords many admirable sites along its course.

The Tallulah, in Rabun county, falls 450 feet in one mile at the Tallulah Falls, so well known for its picturesque beauty and for the sublimity of its "Grand Chasm." The James River, in Virginia, has a great fall as it flows through that famed valley where Pocahontas and Captain Smith wandered, before Hargreaves invented the upright spindle to be driven by steam or water power. Many of your readers have seen and admired the beautiful rapids at Richmond, Va. The Oostenaula, Etowa, and Chickamauga rivers in Upper Georgia all afford water power. At Tangipahoa, in Louisiana, I understand there is a very fine power. But there is enough for all for, perhaps, a hundred years to come. The Union will certainly need the 20,000,000 spindles by A. D. 1900. Where shall the new mills be located? There are mills in the South that receive cotton loose, "in the seed," in two and four horse wagon loads, direct from the fields; weigh it on wagon scales in the mill yard (as you do hay), gin it in the mill and convert it into yarns immediately. I have often seen "seed cotton" received in this way in the morning and spun into faultless yarn before night. This saves the trouble and expense of baling. Even when baled it reaches the Southern spinner in the loosely packed planter's package, not after compression (for shipment) under a pressure of many hundred tons into a bulk one-fifth that of the planter's bale, in which state it remains as hard as a board for six to twelve months before it reaches the distant mill. Can any one doubt that the Southern spinner may safely dispense with part of the violent and destructive "beating" that is necessary to the Northern and foreign spinner to restore that life and elasticity of fiber which have been squeezed out of it by the gigantic compresses of the present day? So much for Southern water power, as compared with steam. There is much of it north of the Potomac, but much more available here, at the cotton fields, and never impeded by ice.

THE COURSE OF PROGRESS.

Northern manufacturers excel us now in design and coloring and weaving skill, and will long continue to do so; but in the manufacture of the heavier cotton cloths and of the lower numbers of yarn we are firmly established and perfectly successful, as the extremely satisfactory dividends from many Southern mills sufficiently attest. Northern weavers give up to us the heavy goods and buy annually hundreds of tons of Southern yarns. Why is this? Simply because we can spin as well as any other spinners, and more cheaply. If it were not so would these skillful and thrifty people buy of us? As we increase the production of yarns more and more mills will be started North to consume them, and as Northern weavers learn more and more to depend upon us for their supplies we will, before long, be spinning finer numbers of yarns, and then the spinners of the North must go to 80's and 100's. We will soon, probably, compete with the North in manufacturing print cloths, to be printed there into the exquisite calicoes they now make. Finally, we will commence spinning fine yarns for exportation to Europe.

The great impediment in the way of immediate and rapid progress is the poverty of the people, but this is rapidly passing away, and we will be able to take a respectable portion of the new spindles that will soon be needed. Before the end of this century the Southern States will present a very different aspect. With such advantages as we have (the story is not near told) is it not strange that the vast accumulations of wealth, North and East, and in England, do not find their way to this favored region, which lacks nothing but capital to create a manufacturing industry in this line that will not only be very remunerative, but will add to the glory of the reconstructed Union and make it yet more signally the "wonder of the nations?" Hundreds of thousands read your bright cosmopolitan journal. You can reach them with sound suggestions on this important subject. Can you accept the views here suggested? If you can, send them abroad, East, West, North, and South and "across the waters," and let us see these magnificent streams, now wasting their wealth of power in the Atlantic and the Gulf, harnessed and made to minister to our progress and the progress of the American people.

MESQUITE BREAD.

A COMMUNICATION was lately read before the California Academy of Sciences, written by Capt. J. A. Mellon, of the sloop Southwest, Colorado River, who furnished cans containing seed of the mesquite tree, explaining that the screw bean bears two crops a year, the first ripening in June, the tree being in bloom for the second crop at the same time. He had a wheel on his craft made from the wood of the screw bean, and it acted admirably, as it did not check, and it shrinks very little, although exposed to the sun. The Indians depend mostly on the mesquite for their supply of winter's food. He sent a sample of the bread they made from the fruit. When the bean is ripe they collect it in large baskets, and pack it to the nearest point on the river, where there is a ledge of rocks. In all those places they have mortars formed by grinding into the ledge, and there the old squaws work pounding it up, moulding it in baskets, and drying it in the sun for winter use. Their loaves sometimes weigh twenty pounds.

When the crop is all harvested they build a platform about three feet off the ground, and store it away until their corn, pumpkins, and melons are gone, when they draw on their mesquite bread. The beans are also used as horse feed, and at the mill it sells for three cents per pound. When there is a scarcity of hay, barley and beans are the food, and when hay is plentiful beans and hay are the fodder, and the teamsters say it wears first-rate. He believed that the screw bean would make the finest of treenails for shipbuilding, as the longer it stays under water the tougher it becomes. He did not think it would grow north of 38° of latitude on this coast, and on the Atlantic not north of 30°. In good soil it is a rapid grower, and he thought it would make a good hedge plant.

Dr. Kellogg called attention to the durability of the mesquite tree, and explained that he had been in a building which had stood almost a century, and the wood was perfectly sound. It partook of the nature of our firs, and, although the wood was somewhat brittle, it was, when dried, very rigid. The mesquite furnished the very best kind of girders for internal structure. Dr. Englemann, of the United States Forestry Commission, who was requested to dwell upon the peculiarities of the mesquite, stated that he had just returned from the southern part of Arizona, where he found extensive woods of the mesquite tree, miles in extent and breadth, south of Tucson. There the trees were larger than is generally seen, some of them being a foot, and even two feet, in diameter, and something like thirty or forty feet high. They had the aspect of the willow tree, but he would compare them to the olive of southern Europe. Straight stems were very rare, they being very much inclined to be crooked.

The Mexicans managed to cut posts or timber of eight or ten inches in diameter, and ten feet long, which they sold in Tucson, where they were used in building, proving almost indestructible and unaffected by moisture. They were used as girders over openings, such as doors and windows. They are very durable, as was proved by the fact that mesquite timber was found in those ancient dwellings on the Gila River, the prehistoric dwellings well preserved. The wood was very heavy, and was the best for fires that they had there, and probably in existence. It afforded very little shade, and the ground beneath was covered with grass and low herbaceous plants.

OAK AND CACTUS.

Some beautiful elongated acorns had been presented to the society, and some of the members requested Dr. Englemann to make some remarks on oaks. He stated that it was well known among carpenters and wood-workers generally upon this coast, that the oaks here are quite inferior to those of the East. There was only one species here which was really of any value, and that was a species of live oak, which was very hard, heavy, and durable. There were four or five species of white oaks upon this coast, but none of them are equal to the Eastern white oak. There were ten or twelve species altogether here. The president noticed that specimens of the *nestoc* had been donated. It grew rapidly, and it was only troublesome when it began to decay, giving the drinking water a very unpleasant, if not unhealthy, odor. Dr. Parry handed up a sample of cactus grown in this country. Dr. Englemann was again requested to say something about the cactus. He complied by stating that the *cacti* are found a foot and even two feet in diameter, and from 30 to 60 feet high. The wood is distributed in separate bundles, which are as long as the cactus itself. These sticks, more or less round, are two inches in diameter. The Mexicans cut down cactus, and allow the fleshy or pulpy part to decay, collecting the sticks which are brought into Tucson by wagon loads, and used like laths. They are very strong, usually do not break, and last almost for ever. The cactus itself was much more common than was generally known, the hills around Tucson being covered with them.—*Mining and Scientific Press.*

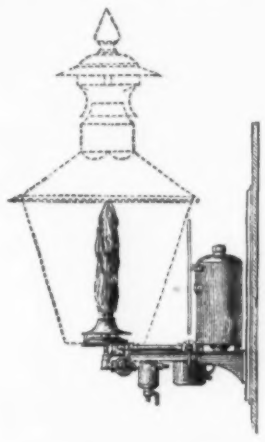
TAR OIL LAMP.

THE gas-oils and tar-oils which contain a great deal of carbon, are used very little for other purposes, but make very economical burning material.

The inventors have discovered a device by which the light of the oil flame is made brighter and more advantageous. This device consists in leading through the flame a stream of steam, which furnishes the quantity of air necessary for the combustion and produces at the same time a chemical effect, which consists in decomposing the steam at a high temperature and in the presence of carbureted hydrogen, thus forming a mixture of gases which secretes no carbon and gives an extraordinarily clear and bright light.

The lamp can be placed wherever steam can be had, and if used in free air must be placed in a lantern.

In placing the lamp it is necessary to be careful that the



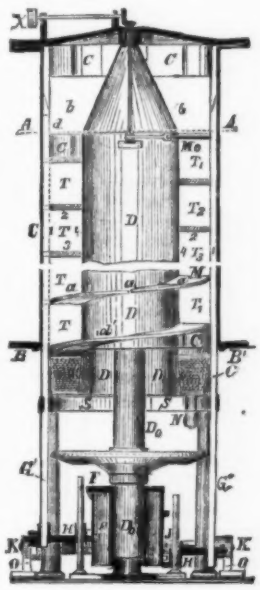
dish-shaped burner is horizontally mounted, so that the oil in the dish is everywhere of the same depth. The oils used in these lamps are much less inflammable than coal-oil and are perfectly harmless, though used without wicks and without chimney.

The steam must be as dry as possible, and there must be an arrangement for carrying off the condensed steam or water. The oil vessel holds about 30 quarts of oil, and this quantity is sufficient for even the longest night. First, by opening the tap three-quarters of the burner is filled with oil, after which the tap is closed. A small quantity of coal-oil has to be added to the oil in the burner, as the tar oil is very little inflammable. The oil is then lighted and sufficient steam to prevent smoking is admitted, after which the tap is again opened and more oil enters.

In using 2¼ lb of coal-tar-oil a light equal to about 180 candles is produced, and the cost is about a third of that of gas.

APPARATUS FOR CONTINUOUS DIFFUSION.

THIS diffusor consists of a fixed cylinder, C, and a cylinder, D, which can be turned by means of the axis, D*o*, and which is encircled by the screw windings, M. This screw, M, reaches from the line, A A¹, to the line, B B¹, and nearly touches the walls of the cylinder, C. The walls of the cylinder have eight hollow ribs, in which eight rods, G, are movable. To these rods tin plates are fastened at their side, 1, their sides 2 and 3 closely pressing toward the windings of the screw, M, and the side, 4, touching the wall of the cylinder, D. By these plates, therefore, each worm of the screw is divided into eight cells, and seven of these cells



lay one above the other and above the eighth, which is formed by fixed separating walls, *b*, at the cylinder, D, above the screw, M. The eight plates, *b*, lie above the eight upper plates, T. By a whole rotation of the screw, *m*, the vessels, T, are slowly lowered to the extent of the height of one worm of the screw. If this has been done they are raised again by the following arrangement:

The rods, G, are fastened to a ring, S. Two of them extend beyond the ring and are fastened to the rods, H, which are connected by the ring, I. These latter rods are attached to the levers, K, which are movable around the *o*, and carry weights at the other side of O. By means of these weights the whole system of the vessel, T, is carried and pressed somewhat upward. This pressure is communicated to a screw, F, which is supported by the rods, H. Two openings in F, through which the rods, H, penetrate, and openings, *a*, in *m*, through which the tin plates, T, enter, make

it possible to raise again the whole system of cells to the height of one worm of the screw.

By the turning of M and the ascending of T, the shreds which are brought into the apparatus from above are gradually conducted through the seven superimposed cells. The shreds meet on their way a current of water which enters through a pipe indicated at *d*, and which, mixed with a solution of sugar, flows out at *d*.

The upper margin of the screw, M, is a toothed knife, Mo, and above it there is another toothed knife which is turned together with M, and moved hither and thither in a radial direction by the disk, X. These two knives work similar to the knives of a mowing machine, the screw cutting into the mass of shreds.

The space between the cylinder, C and D, is made somewhat narrower below B B, by means of two conic perforated sieves. In these sieves the shreds are pressed together and are removed at the lower part; the water passing through the perforations of the sieves flows off through the tube, N.

ON BUNSEN'S METHOD FOR DETERMINING FREE OXYGEN IN WATER.

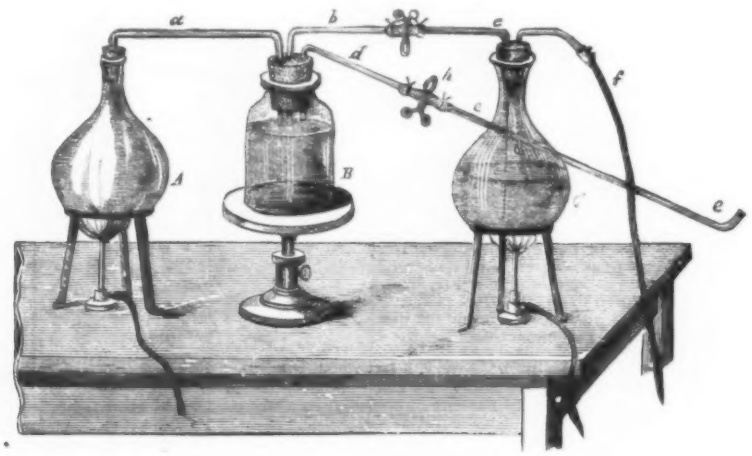
By J. KOENIG and C. KRAUCH.

THE gases are expelled from the water and collected by means of the following apparatus (*Zeitschrift Anal. Chemie*, Fig. 17, p. 240, 1880). The use of this apparatus is exceedingly easy and convenient.

The vessels, B and C, are filled (the former entirely, the latter only half) with water which has been boiled for some time so as to be free from air. The glass tubes, *a*, *b*, *c*, are also filled by blowing into the flask, *c*, and opening the pinch-cock, *g*. The flask, A, is then entirely filled with water which has been thoroughly boiled, and is free from air, and quickly connected with *a*. If, while effecting the connection, we close the pinch-cock, *g*, the stopper is generally spontaneously pressed into the flask, A, the water of which is colder than that in B and C. The flask, A, is then boiled for some time, which brings the water in B also to a boil, and after opening *g*, it is driven into the flask, C. When this has taken place entirely or partially the gas flame is removed from under A. In consequence of the cooling the water flows back from C into B and A. The air which is still present collects underneath the stopper in B, and is expelled by opening the pinch-cock, *h*, and blowing into the flask, C.

This boiling and driving the water backward and forward from A and B into C, is continued before every determination till no more air collects in B. When this is effected the pinch-cock, *g*, is closed, the flask, A, is quickly removed, emptied, and filled entirely with the water under examination. During this operation a little air always enters into the tube, *a*, but by closing *g*, and blowing air into C, *a*, can be easily and entirely refilled with the deaërated water, and when the stopper is quickly placed in the flask, *a*, which has been entirely filled with the water to be examined, on simultaneously opening the pinch-cock, *g*, A may be connected with B, in such a manner that not a bubble of air enters. A is next heated to a boil, leaving *g*, open, when the air present in the water, mingled with watery vapor, passes into B. The boiling in each case must, however, not be continued till all the water in B has been driven through the tube, *b* (which reaches to its bottom) into C, as then some of the air would also be expelled.

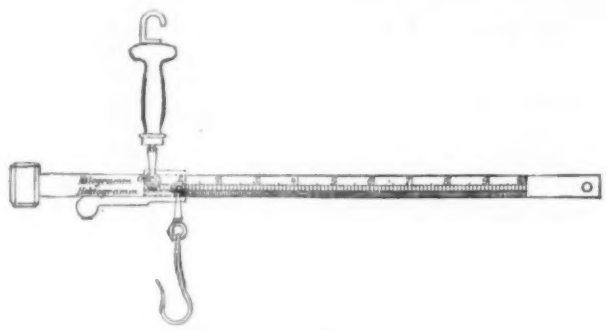
When the water in B has been expelled down to about the middle of the vessel the flame is removed from beneath A, whereby water passes again from C to B and A, while the expelled air collects in B, underneath the stopper; as soon as A is entirely filled with water the boiling is resumed and repeated in the same manner from 6 to 10 times. When the air has thus been completely expelled from the water in A—which is very difficult and can scarcely be effected with quantitative accuracy—the flame is removed from A, which is allowed to fill itself again with water, the pinch-cock, *h*, is opened, and the air which has collected in B is driven by blowing into C, completely out of B, through the tube, *d*, *e*, into the eudiometer. This can be easily and accurately effected. A certain quantity of water is indeed carried along into the tube of the eudiometer, but this serves to dissolve the solid potassa which is introduced in small fragments in order to absorb the carbonic acid present in the air. When no further decrease takes place the volume of air is measured, noting the indications of the barometer and thermometer. In order, in this mixture of nitrogen and oxygen, to determine the latter, a concentrated solution of pyrogallic acid is employed, which is left in contact with the air for several hours, frequently agitating the tube.



The level of the pyrogallic solution and the column of mercury are measured, and like the water pressure reduced to mercurial pressure. In calculating the volume of gas at 0° and 760 mm. pressure the tension of the vapor of pure water is assumed, and not that of the potassic solution of pyrogallic acid. This assumption is not quite accurate, as the potassic solution has a somewhat higher specific gravity than 1, and its tension is less than that of pure water. As in the first case too small a quantity is subtracted from the barometric reading, and in the second case too much, the trifling error is compensated. Where great accuracy is required the sp. gr. of the potassic solution should be determined. (See also "Bunsen's Gasometric Methods," 2d edition, 1877, p. 387).—*Zeitschrift Anal. Chemie.*

STEELYARD WITHOUT WEIGHTS.

AN improvement of the common steelyard, devised by D. J. Tengelin, of Stockholm (German Pat. No. 7,988, class 42), dispenses with the movable weight by making the beam itself serve the purpose. As shown in the cut, the latter may be caused to slide to or fro in a case to which the bearings are attached, being provided on one end with a permanent weight, and with the usual divisions of the metric weight. The scale is balanced when the zero mark just appears in front of the fixed case. After appending the substance to be weighed to the hook, the beam is drawn through the case toward the side provided with the weight, until equilibrium is restored, and the division of the scale which is just in front of the case represents the weight of the substance.—*Dingler's Polyt. J.*



TENGELIN'S STEELYARD.

THE HEAT OF COMBUSTION OF THE GASEOUS HYDROCARBONS.

AMONG the determinations of physical constants, an important place must be assigned to those which give the exact amount of heat developed by the chemical union of the various elements with each other. Of special interest are the measurements of the heat developed by the combustion of carbon and its compounds; that is, by the chemical union of carbon and the hydrocarbons with oxygen to form oxide of carbon in the one case, and oxide of carbon and oxide of hydrogen in the other.

M. Berthelot has lately determined the heat of combustion of the hydrocarbons which do not liquefy above the freezing point, by exploding them in a steel shell with pure oxygen. The steel vessel, lined on the inside with platinum, is closed with a platinum screw, having in its center a capillary tube opening below the threads of the screw, and between them and the conical head, which can be pressed down by a turn of the screw into a conical neck, when the gases have been admitted through the capillary tube into the vessel. A platinum wire is brought through a plug of ivory, as an insulator, into the interior, so that an electric spark can be passed between the wire and the interior surface of the shell. The vessel is plunged into a water calorimeter of the form employed by Regnault in determining the specific heats of the elements. A delicate thermometer, by the side of the shell, indicates the temperature gained by the water, from which the heat of combination is calculated in thermal units according to the metric and centigrade scales. The thermal unit is the quantity of heat required to raise 1 gramme of water from 0° to 1° C.

When 12 grammes of carbon, in the form of diamond, unite with 32 grammes of oxygen, the heat developed is 94 units, *i.e.* enough heat is produced to raise 94 grammes of ice-cold water through 1° C. In the following determinations the weight of the combustible taken is proportional to its molecular weight. Carbonic oxide being composed of 12 parts by weight of carbon to 16 parts of oxygen, the heat developed by the combustion of 28 parts by weight of carbonic oxide is compared with the heat produced by the combustion of 12 parts by weight of carbon. By exploding 28 grammes of carbonic oxide with 16 grammes of oxygen, Berthelot found the heat evolved to be 68 thermal units. The number agrees admirably with that deduced by Andrews—viz., 68·1 units. Carbon burns directly to carbonic acid, and does not combine with oxygen directly to form carbonic oxide; but since the total heat due to the burning of 12 grammes of carbon to carbonic acid is 94 units, and the heat due to the burning of 28 grammes of carbonic oxide, containing 12 grammes of carbon to carbonic acid is 68 units, the difference, or 26 units, is the heat due to the union of 12 grammes of carbon with 16 of oxygen. By exploding 2 grammes of hydrogen with 16 grams of oxygen to form water, the heat of combustion was found to be 69·2 units.

It appears, then, that *equal volumes* of hydrogen and carbonic oxide, when burnt with oxygen, evolve very nearly the same quantity of heat. In the following determinations the weights of the different hydrocarbons exploded are proportional to their molecular weights, so that in each case the thermal result is due to the burning of an equal volume of the combustible: When 16 grammes of marsh gas (CH_4) were exploded with oxygen, they gave 212·4 thermal units as the mean of three experiments; 30 grammes of ethane (C_2H_6), prepared by the electrolysis of potassium acetate, gave on explosion 387·4 units; 28 grammes of ethylene, or olefiant gas (C_2H_4) gave 340·3 units; 26 grammes of acetylene (C_2H_2 gave 315 units. Of the hydrocarbons containing three atoms of carbon the following gases were employed—viz., the paraffin propane (C_3H_8), the olefine prophylene (C_3H_6), and the acetylene allylene (C_3H_4). The propane was obtained by the action of concentrated hydriodic acid on cyanhydrate of ethylene, and was separated from hydrogen by dissolving it in absolute alcohol. Of the above, 44 grammes of propane evolved 552 heat units in burning to carbonic acid and water; 42 grammes of propylene evolved 506 heat units; and 40 grammes of allylene, prepared from acetone chlorhydrate, evolved 465 heat units.

Cyanogen gas (C_2N_2) gave, for the combustion of 52 grammes, 263 heat units. In 52 grammes of cyanogen there are 24 grammes of carbon. Now we have seen that 12 grammes of carbon burning to carbonic acid evolve 94 heat units, and therefore 24 grammes of carbon burning to carbonic acid evolve $94 \times 2 = 188$ heat units. But when cyanogen burns in oxygen, only the carbon is burnt to carbonic acid, while the nitrogen is liberated. The excess of heat evolved by the burning cyanogen it due in part to the separation of the carbon from the nitrogen. We have in this difference, then, a measure of the heat which was absorbed in the union of the carbon and the nitrogen. The measure of heat so obtained by subtraction requires modification in this case for the following reason: That a certain quantity of the heat developed by the combustion of solid carbon in oxygen is absorbed in vaporizing the carbon—disappears, in fact, as the latent heat of gaseous carbon; whereas the carbon in cyanogen is already gaseous and (as latent heat) is abstracted from the heat developed by the combustion. But in the case of the hydrocarbons the combustibles and the products of combustion are in the gaseous state, so that the heat of formation of the various compounds can be ascertained with considerable accuracy. In the following table is given a list of combustible gases with their heats of combustion and their heats of formation so deduced:—

Gas.	Formula.	Heat of Combustion.	Heat of Formation.
Hydrogen.....	H_2	69 ...	—
Carbonic oxide.	CO	68	+26
Cyanogen.....	C_2N_2	263	−75
Marsh gas.....	CH_4	212·4	+19
Ethane.....	C_2H_6	387·4	+ 7·6
Ethylene.....	C_2H_4	340·3	−14·3
Acetylene.....	C_2H_2	315	−58
Propane.....	C_3H_8	552	+ 6
Propylene.....	C_3H_6 ...	506	−17
Allylene ...	C_3H_4	465	−45

In the last column of the table the sign + means that so many heat units were given out in the formation of a compound, the sign − that so many heat units were absorbed in the formation of a compound.

These numbers show that the heat of combustion of a hydrocarbon is never equal to the sum of the heats of the combustion of its elements. It is less for the hydrocarbons of the paraffin series than for the others—a fact which shows that heat is given out in their formation, and accounts for their relative stability. The union of carbon with hydrogen in the unsaturated hydrocarbons is attended by an absorption of heat, and this absorption is greater in the acetylene series, where two carbon atoms are joined together by three bonds, than in the olefine series, where two carbon atoms are joined together by two bonds. The union of an olefine with hydrogen is therefore attended by an evolution of heat; the reaction between hydrogen and ethylene ($C_2H_4 + H_2 = C_2H_6$) yields 22 heat units, and the reaction between acetylene and hydrogen ($C_2H_2 + H_2 = C_2H_4$) yields 45 heat units.—*Journal of Gas Lighting.*

CRYSTALLIZED CALCIUM OXIDE.

By A. LEVALLOIS and S. MEUNIER.

A CRYSTALLINE mass, in some parts white, in others slightly colored, found on the lining of a continuous lime kiln which had been in almost uninterrupted operation at Champigny for twenty-eight months, consisted partly of rounded grains, partly of small distinct cubical crystals. These crystals, the angles of which were in some cases slightly modified, were opalescent and had no action on polarized light. When exposed to the air they slowly absorbed a small quantity of water and carbonic anhydride, and when placed in water were gradually dissolved. Dilute acids were almost without action in the cold, but, if slightly warmed, the crystals were rapidly dissolved with considerable evolution of heat, but no gas was given off. Analysis gave the numbers CaO, 96·9; H_2O, 1·9; insoluble matter, 0·8 = 99·6; sp. gr., 3·32. Probably the crystalline oxides of the allied metals and magnesium may be formed in a similar way.—*Compt. Rend.*

GLOVER'S TOWER FOR MANUFACTURING SULPHURIC ACID.

GLOVER'S tower, which was erected for the first time by John Glover at the Wallsend works, near Newcastle-on-Tyne, fills several rôles in the manufacture of sulphuric acid. First, it serves as a condensing apparatus. The sulphurous acid and other gases proceeding from the furnaces where roasting of the pyrites is being effected reach this tower at an elevated temperature, and come in contact therein with the sulphuric acid, which is concentrated through loss by evaporation of a large portion of its water. These aqueous vapors are led into a leaden chamber, where combination. Moreover, the acids of nitrogen set free are led back into the leaden chambers, where they serve anew for the transformation of sulphurous into sulphuric acid. Finally, Glover's tower may be considered as a washer in the sense that it retains the dust coming from the pyrites furnace. There is thus obtained in the leaden chambers a pure acid. Glover's tower, properly so called, is shown in Fig. 1 in elevation, and in Fig. 2 in longitudinal section. It is constructed of very strong lead plates weighing 67 kilogrammes per square meter, and is supported by a wooden framework.

A represents the furnace for roasting the pyrites and the production of sulphurous acid.

form an open lattice work; so that a transverse section of the spaces left between the bricks is always larger than the internal diameter of the pipe, C. The manufacture of the refractory bricks used in the construction of the tower requires particular care, in order that they may not be attacked by the acid, even at a high temperature. It is especially important for this purpose to use only the very hardest bricks.

Above the tower are placed two wooden reservoirs, *a* and *b*, lined with lead (Figs. 1 and 2). One of these contains the acid coming from the leaden chambers and which is to be concentrated; and the other, the nitrous sulphuric acid which has passed through the Gay-Lussac condenser and

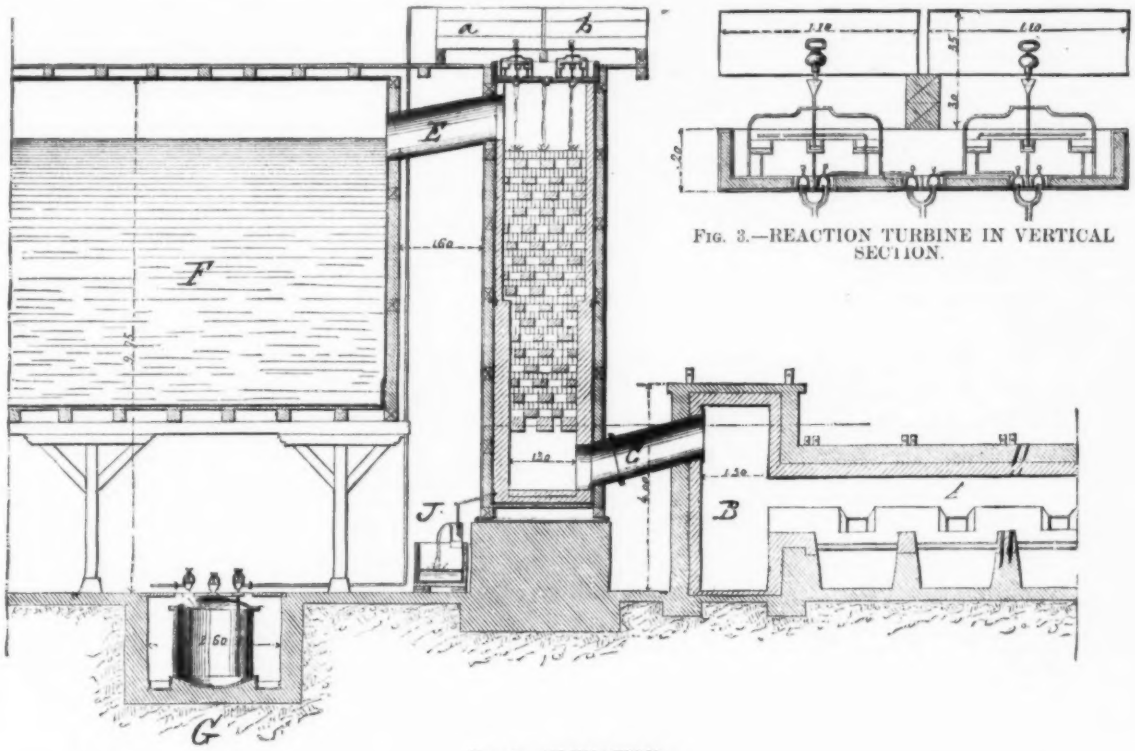


FIG. 1.—ELEVATION.

FIG. 3.—REACTION TURBINE IN VERTICAL SECTION.

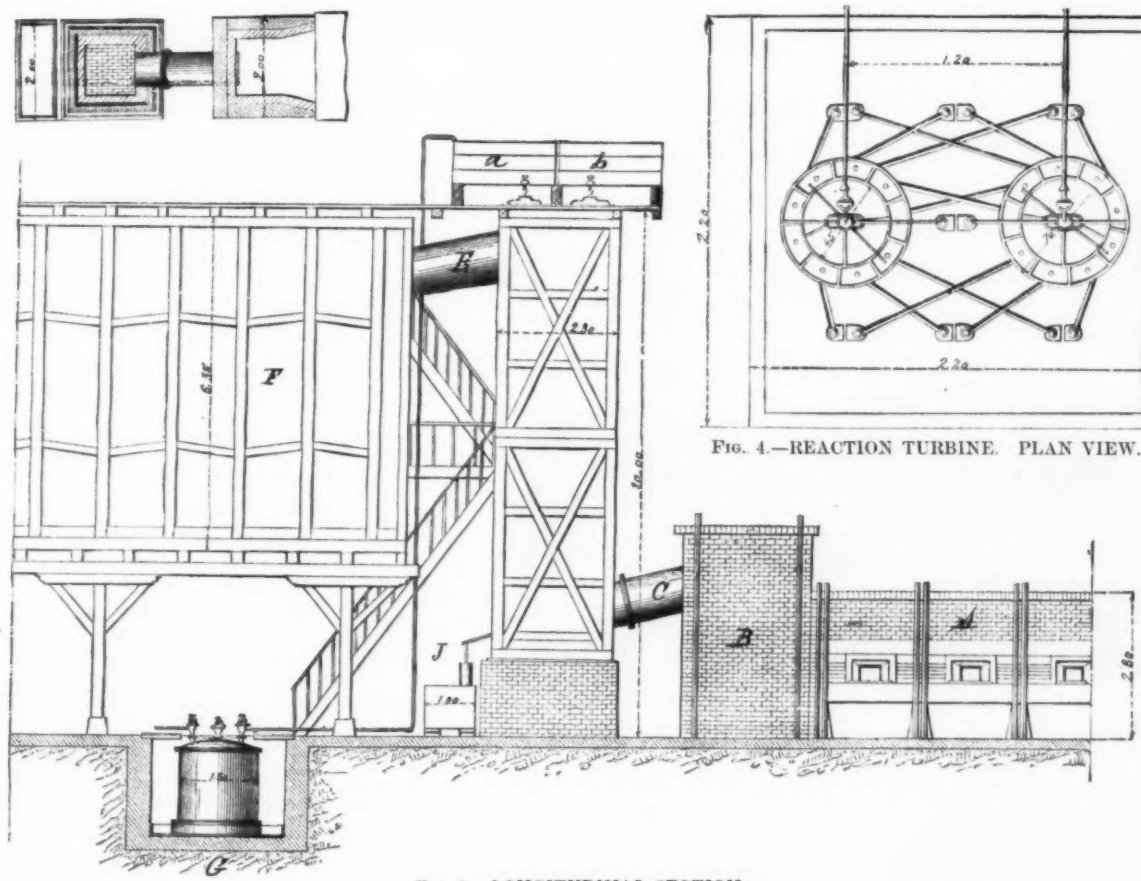


FIG. 2.—LONGITUDINAL SECTION.

FIG. 4.—REACTION TURBINE. PLAN VIEW.

GLOVER'S TOWER FOR THE MANUFACTURE OF SULPHURIC ACID.

they serve, along with the nitrous gas, for the oxidation of the sulphurous acid. The latter acid reaches the chamber in a remarkably cool state; and this, as regards the preservation of the leaden walls, is a manifest advantage.

Glover's tower is, at the same time, a denitrification apparatus for the nitrous sulphuric acid (as the sulphuric acid is called which, in issuing from the leaden chamber and passing through the Gay-Lussac condenser, comes in contact with nitrous gases and absorbs a considerable proportion of them). This nitrous sulphuric acid is decomposed in Glover's tower, by the combined action of the aqueous vapors and the sulphurous acid, so completely that the sulphuric acid flowing from the tower is entirely freed from all nitrous

B, Chamber in which is collected the dust which is carried along by the gases coming from the furnace.

C, Cast-iron pipe, lined with lead, for leading the sulphurous acid into the tower. A clay pipe, two and a quarter inches thick, is often substituted for the iron one.

E, Lead pipe for conducting the sulphurous acid into the leaden chamber, F.

In order to prevent the leaden walls from deteriorating too rapidly they are lined with refractory bricks—the lining being thicker in the lower part than in the upper.

In order to multiply the surfaces of contact of the sulphuric acid with the gases, other refractory bricks are arranged throughout the whole tower in such a way as to

which must be denitrified. The acids are forced into these reservoirs by means of compressed air contained in the receptacle, G. A small glass turbine (Figs. 3 and 4) serves to spread them over the entire surface of the bricks with which the tower is lined. The acids flow from the reservoirs through two clay cocks into the funnels of the turbines, and escape through their inclined tubes that they put in motion, and which, in their turn, distribute the liquid uniformly into a circular series of cells formed by bricks properly arranged. From these cells the liquid flows vertically through leaden tubes which are fixed in the base of the tower and are provided with hydraulic gates. The apparatus is so arranged that the sulphuric and nitrous acids unite in the

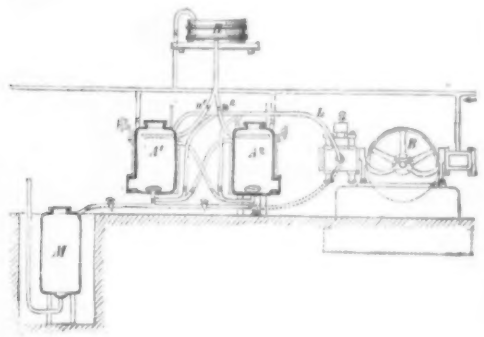
interior of the tower in a forked tube, and flow out together. After traversing the bricks the concentrated acid falls into the reservoir, J (Figs. 1 and 2).

A NEW APPARATUS FOR MANUFACTURING GELATINE AT A TEMPERATURE WHICH IS BELOW THE BOILING POINT OF WATER.

Invented by ABRAHAM ZWILLINGER, Vienna.

THIS apparatus gives much better results than those previously used. Its advantages consist in the facts, that the greatest part of the gelatine, mostly 20 to 27 per cent., may be directly obtained from the steaming reservoirs, that the gelatine does not come in direct contact with the steam and with overheated surfaces, that it therefore does not become altered, and that, besides, the glue products may be obtained with certainty and equality at all seasons of the year. The construction of the apparatus may be seen from our illustration.

A^1 and A^2 are the two steaming reservoirs, each of which, if filled to three-fourths of its height, is able to hold 39,600 lb. of bones. These bones are washed once more with cold water, which afterward flows off through the taps, n_1 and n^2; then steam is admitted into A^1, in order to force out any

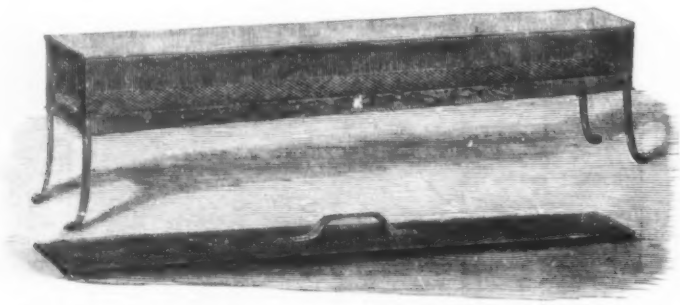


A^1

water that may still remain, and the pressure is brought upon 2–3, and kept for about an hour and a half at this height. At the end of this time the steam is led through L into A^2, here the same pressure is established and prolonged for the same length of time. This operation is repeated from three to six times; the gelatine is drawn off from every quarter to every half hour, and the decrease of pressure which is thereby caused is equalized by admitting new steam. Afterward, the bones in the steam reservoirs are alternately macerated by means of hot water, which enters from the reservoir, R, which has meanwhile been heated, and by means of air compressed to three, coming from the compressor, B; finally, they are again treated with steam till the extraction is completed. The gelatine is collected in the Montejus, M, and brought afterward into fermentation-vats where it is condensed in the vacuum to 45°.

APPARATUS FOR COATING LABORATORY TOOLS.

METALLIC tools and other articles, particularly those consisting of iron or steel, which are used in laboratories or other workshops where acid vapors are of frequent occurrence, may be protected from rust with a black shining coat which resists acids and is but little affected even by a low red heat, in the following manner. Have a sheet-iron box (see figure) constructed, large enough to hold all the tools, etc., to be coated, and provided with a false bottom of wire netting. Underneath this is placed a layer of crushed coal (blacksmith's coal), about one centimeter deep; then place the tools, which must be entirely free from rust, clean and polished, upon the wire net. The box is then covered and set on a strong fire, which causes the coal to give off tarry constituents, and the heat continued until the bottom of the



APPARATUS FOR COATING LABORATORY TOOLS.

box is at a red heat. When all evolution of gas has ceased, the box is allowed to become cold and the tools are taken out, and will be found covered with a beautiful glossy coat. Tongs, shear, pincers, etc., so coated, keep in good condition for many months, even in places where the air is constantly mixed with acid vapors.—*Technik der experimental. Chemie.*

AN EXPERIMENT WITH SULPHUR.

By T. GROSS.

THE author doubts the elementary character of sulphur. By heating a mixture of sulphur (commercial milk of sulphur*) and linseed oil in an open basin, he obtained a black porous mass, which dissolved in concentrated sulphuric acid, after long continued heating, to form a sirupy liquid. After dilution, sulphureted hydrogen was passed into this liquid, and produced a light brown precipitate, soluble in ammonium sulphide or in hot potash solution. When burnt in air, this precipitate left a black residue, which was not acted on by inorganic acids, was not attacked by oxygen even at a red heat, and was but slowly and partially changed by chlorine with formation of a sublimate, which was reduced to the original black substance by the action of hydrogen.—*Chem. Centr.*

* No attempt seems to have been made by the author to ascertain whether the sulphur was pure or not.

PROCESS FOR THE MANUFACTURE OF AMMONIAC FROM LEATHER RUBBISH BY MEANS OF DISTILLATION WITH CARBONATE OF LIME.

IT has long been known to chemists that sulphate of ammonia can be produced from old leather rubbish but this process has not hitherto been used in factories, because it was believed to be too expensive. Mr. Hermann Proschwitzky, of Stettiro (Patent of the German Empire, 10,957, of February 10, 1880), has now received a patent for a proceeding by which this chemical substance may be manufactured by distilling old leather scrap together with quick

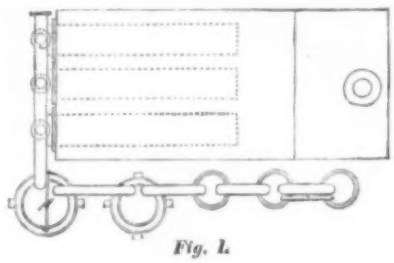


Fig. I.

lime. The quality of the product thus obtained is quite as good as that obtained from the refuse wash water of gas factories or from bones, and this process is much cheaper than the usual ones, because the value of the remainder and of the accidental products covers the expenses of the materials used and of the production.

The retorts are filled with alternate layers of leather scraps and lime (each of the latter having four times the weight of each of the former) and are then closed by a cover which is made air-tight by fastening it down with screws and cement. Into the vessels, *c*, *d*, *e* (Fig. I. and Fig. II.), is poured as much sulphuric acid of 30° B., as is necessary to absorb the ammoniac developed from the leather. These vessels are of wood and lined with lead. The vessels, *a* and *b*, are

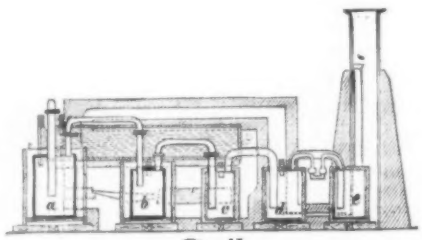


Fig. II.

made of cast iron and placed into cooling reservoirs, and in the former carbonate of ammonia, gall-water, and tar are deposited.

In order to know exactly whether the distillation is finished or not, the vessels, *d* and *e*, are connected by means of a Weber's bulb-tube, the liquid contained in which, indicates the increase and decrease of pressure in the retorts. If the pressure should be too great, the tap of the collecting tube must be opened in order to prevent the liquids from rising into the retorts.

When the vessels have been filled and closed, the retorts are heated to a red heat and kept in that condition till the pressure ceases, which will be the case in about four hours. After this the contents of *a* and *b* are put into a barrel, which is furnished with a tap at the bottom. When the tar and gall-water have been separated, the former, which contains the carbonate of ammonia in solution, may be drawn off as a clear liquid. This liquid, and the contents of the vessels, *c*, *d*, *e*, are poured into a flat leaden pan, *f* (Fig. III.), a part of the water is evaporated by means of an evaporation spiral, and the remainder is brought into shallow leaden vessels, *g*, where, after cooling, the salt is deposited.

The remaining liquid which still contains an excess of sulphuric acid may be used again.

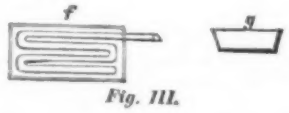


Fig. III.

Another method for separating the salt from the liquid, is to saturate the product contained in the vessels, *a* and *b*, after it has been clarified in the manner mentioned above, with sulphuric acid, to use the sulphuric acid contained in the vessels, *c*, *d*, *e*, until it has become perfectly neutralized, and to continue with the evaporation of both products until all the salt has been extracted.

After the fire has been removed from under the retorts, and when these have become somewhat cooled, the contents are taken out and brought into an air-tight vessel made of bricks, where they become perfectly cold. These remaining products are finally separated from each other and may be used to advantage. During the manufacture a great quantity of gas is developed which may be profitably employed for the heating of the retorts.

REDUCTION OF GOLD AND SILVER FROM ORES CONTAINING SULPHUR, ANTIMONY, OR ARSENIC.

(Patent of the G. A., 10,716.)

THE ores, which are reduced to very small pieces, are heated in a retort to dark-red heat, and a current of hydrogen is led through them. By this process sulphureted hydrogen is formed, while the arsenic is sublimated. The remaining ore, which still contains undecomposed sulphurous copper, is ground and roasted upon a hearth, whereby the sulphurous is transformed into sulphate of copper and oxide of copper, and, besides, oxide of antimony and tetroxide of antimony (antimonoxide antimoniate) is formed. The oxide of copper is now dissolved in cold sulphuric acid of twelve per cent. The copper is precipitated in this solution by means of iron. The remainder is treated with concentrated muriatic acid in a vessel which is tightly soldered with lead; by this treatment the combinations of antimony are transformed into chloride of antimony, and this liquid is finally decanted. The remainder now contains all the gold and silver, which was originally contained in the ore. If only the extraction of silver is required, this metal may be obtained by dissolving the chloride of silver in natriumthiosulphate. If both gold and silver are to be extracted, it is done by a process of amalgamation. In order to extract gold and silver by a dry process, the dechlorated remainder is mixed with one half of its weight of litharge and one fiftieth of its weight of pulverized charcoal. The mixture is molten together with lead and stirred up with green wood. The noble metals are reduced by zinc or any other adequate method.

THE THERAPEUTICAL USE OF THE MAGNET.*

By WILLIAM A. HAMMOND, M D., Surgeon-General U. S. Army (retired), Professor of Diseases of the Mind and Nervous System in the Medical Department of the University of the City of New York, etc.

THAT a magnet is capable of exercising a strong physiological influence over animals and even plants is a fact which, though overlooked or disregarded by physicians generally, experiment has definitely established. The reason for this neglect is doubtless to be found in the circumstance that the promulgators of the science of magnetism in its relations to life have generally mingled so much chaff with the grain of wheat that the latter has been lost sight of in the great superfluity of the former.

Several years ago the subject was investigated by the Baron von Reichenbach, a man who not only was endowed with profound learning, but was held in great respect by Liebig and other eminent scientists. He performed a large number of experiments upon neurotic men and women, and, though much that he deduced from his researches must be regarded as not proven, this can not be correctly alleged of all his conclusions. For instance, that the following observation is true, any one can easily determine for himself. I have repeatedly satisfied myself of its correctness.

"If a strong magnet, capable of supporting about ten pounds, be drawn downward over the bodies of fifteen or twenty persons, without actually touching them, some among them will always be found to be excited by it in a peculiar manner. The number of persons who are sensitive in this way is greater than is generally imagined. . . . The kind of impression produced on these excitable people, who otherwise may be regarded as in perfect health, is scarcely describable; it is rather disagreeable than pleasant, and combined with a slight sensation of cold or warmth, resembling a cool or gently warm breath of air, which the patients imagine to blow softly upon them. Sometimes they feel sensations of drawing, pricking, or creeping; some complain of sudden attacks of headache; not only women but men, in the very prime of life, are found distinctly susceptible to this influence; in children, it is sometimes very active."†

It is undoubtedly a fact that experiments such as these are liable to lead to very deceptive results. All persons are more or less under the operation of the "principle of suggestion;" that is, of seeing and feeling as they are expected or told to see and feel. But, even when performed with every precaution taken to guard against the operation of this factor, phenomena not differing essentially from those observed by Reichenbach are produced. As an example of this, I adduce the following experiment, performed only a few days ago:

A gentleman, thirty years of age, and by no means of an impressionable nature, by request bared his right arm up to the shoulder, and laid it at full length on a table. I then bound a handkerchief tightly over his eyes, and desired him to tell me what sensations he felt in the arm. Having thus induced him to concentrate his attention on that part of his body, I held a strong horseshoe magnet immediately over the nape of his neck and at about the distance of an inch from the skin. In thirty-two seconds, by the watch, he said: "I feel nothing at all in my arm, but I feel a queer, numb sensation at the back of my neck." In about ten seconds more he exclaimed: "It feels now as if you were focusing a sun-glass on the back of my neck." I removed the magnet, and asked him if he felt nothing in his arm. "No," he replied, "I think not."

While he was talking, I hastily brought the magnet over the top of his head, at the same time stroking his arm with a paper knife. "I feel you rubbing my arm with something," he said, "but the numbness has gone out my neck, and is just on the crown of my head."

I then took the magnet away, and then moved it over the arm, from the shoulder to the fingers, at the distance of an inch or so from the surface. After two or three passes of the kind, he said: "Now I do feel something in my arm; it is a sensation as if you were sticking pins in it, though it does not hurt." After a few seconds: "Now it feels like the sun-glass all along the arm."

Other modifications of the experiment were made, and always with the like result. It was evident that the magnet produced sensations in parts of the body where its proximity was not suspected.

* Read before the New York Neurological Society, October 5, 1880. From the New York *Medical Journal*.

† "Physico-Physiological Researches on the Dynamics of Magnetism," etc. English translation by Dr. John Ashburner, London, 1851, p. 3.

Reichenbach supposed that such phenomena, and others which he described, were due to a force which he was the first to recognize, and which he claimed was present in the body. He called this the *odic* force—*od*, or *odyle*. When it was present in great quantity, the subjects were regarded as sensitive, and were capable of exhibiting still more decided effects from the action of magnets than those already mentioned. These *sensitives* were almost invariably persons, mostly women, of strong neurotic temperaments. As he says, he preferred those who were frequently troubled with periodical headaches—especially megrim, who complained of temporary oppression of the stomach, or who slept badly without apparent cause, talked during sleep, were restless at night during the influence of the full moon, who were readily disordered in churches or theaters, or were very sensitive to strong smells. When such persons were brought into a dark room, in which were several magnets, they were able after a few minutes to determine the relative positions of these objects by the luminous rays which were given off from their poles.

As illustrative both of the effects of magnets and of the necessity of guarding against unintentional deception on the part of the subject, I cite the following extracts from a letter written by M. Volpicelli,* of Rome, to M. Chevreul, of Paris:

"A physician," says the writer, "possessing an excellent reputation, asserts that, if a magnet be brought into contact with a nervous subject, the magnetism produces many disquieting effects, and notably deranges the health. For my part, I do not think these disturbances are in any way due to the magnetic influence, whose real existence, however, I do not contest; but I attribute them to the influence of the person's imagination. I was invited by the learned medical professor to experiment upon a nervous subject at the Hôpital du Saint Esprit, at Rome. I accepted the courteous offer, but, instead of a magnet, I brought a piece of iron which was not in the least magnetized [?]. The patient had no sooner seen this iron than he was seized with violent convulsions; his imagination was so excited that he could observe the greatest intensity of nervous disturbance.

"I made a second experiment: a magnet was placed in the hand of a person likewise affected with a nervous malady; at the end of a few seconds he became so violently excited that I was obliged to remove it. I was impressed with the conviction that the nervous disturbance was produced by the mere sight of the loadstone, and not by any magnetic action, and several days afterward I was able to convince myself by means of the following process. The same person was called upon to preside at a scientific reunion. I took powerful magnets and placed them in his chair, in his table drawer, and even beneath his feet, without his having the slightest suspicion of any of my preparations; during the *séance*, which continued more than two hours, he had no nervous disturbance whatever, and, at the conclusion of the meeting, he declared, on my asking him, that he felt perfectly well. On being told that he had been surrounded by powerful magnets, he manifested both surprise and fear, as though he were not quite sure of being in perfect health."

But the most philosophical, and at the same time practical, essay on the action of magnetism on living beings is that of Dr. John Vansant.† His experiments were performed both on plants, which cannot be suspected of being influenced by the "principle of suggestion," on insects and other of the lower animals, likewise unamenable, and upon human beings under circumstances calculated to avoid all suspicion of the action of any other factor than that of magnetism.

Dr. Vansant used small steel magnets, capable of sustaining about an ounce of iron, the ends of which were sharply pointed, and which had, for convenience of manipulation, a wooden handle in the middle. As Dr. Vansant's paper is not generally accessible, in view of the importance of the subject I quote the following description from his paper:

"My attention was first particularly directed to the subject of this communication in the winter of 1866, when I observed that a small magnetized steel rod, the *ends of which were finely pointed*, if brought carefully in contact with an exquisitely sensitive blister that had been accidentally produced on one of my fingers by pinching, gave rise, when the southward pole was applied, to a momentary sharp sensation, and seemed to cause the blister to be more painful after the magnet was removed. When the northward pole was used in the same way, no sensation could be felt at the moment of contact, and after removal the original pain remarkably subsided. Struck by this phenomenon, and yet almost doubting my own sensations, I proceeded to inquire if it were possible to recognize a difference between the two ends of a magnet by means of some organ peculiarly sensitive in its normal condition. On trial I found that the conjunctival membrane of the eye would indicate by the feeling which pole it was touched with. I could lay with care the sharpened northward end of the magnetic rod on that membrane without pain or winking, but the instant the southward pole was applied, no matter with how much delicacy, there was a sharp sensation and an involuntary slight closing of the eyelid. The effect was faint but plain. This experiment was repeated on the eye of another person the same day with similar results. After this I made numerous experiments with magnets of different forms and powers (though not at any time with very large ones) applied to various parts of the body, and thought I observed a definite set of symptoms after every application in the same manner to a given part, provided sufficient time had elapsed between the applications for the organ to resume its ordinary state. Finally I became convinced of the genuineness of the phenomena—that they were not to be attributed to the imagination, and that they were as regular in their occurrence and quite as persistent as those following the administration of any medicinal substance."

Dr. Vansant's experiments were mostly of a physiological character. He, however, records three cases in which the magnet was used as a therapeutical measure, and with instant effect. Thus: "Mr. I. R., a gentleman of rather delicate organization, had neuralgia in the upper part of one side of his face. I applied the northward (—) pole of a small bar magnet, not quite capable of lifting half an ounce with one pole, for a few seconds over the painful place. In about ten minutes he said the pain was increased and more localized. I then applied the southward pole in the same way, and in a few minutes he said the pain had nearly ceased. This gentleman *expected* to be relieved by the *first* application.

"Mr. M., a strong, unimaginative man, had facial neuralgia of malarial origin. I applied the — pole of the same small magnet last described over the seat of pain for about one minute. In five minutes he complained of the pain being worse. I then made an application of the + pole, and in less than a minute the pain almost subsided. After about an hour there was a recurrence of the pain for a short time, but much lessened in intensity. This person also, was led to *expect* relief by the first plan of application.

"Mrs. S., a lady of remarkable sensitiveness, but great self-control, was suffering from excruciating neuralgia of the nerves passing out of the left side of the pelvis. The day before, I had injected subcutaneously, near the painful place, one-fourth of a grain of sulphate of morphia, with the effect to produce very great depression of the vital powers, but not to relieve the pain, which continued to be felt during the semi-consciousness that followed. On this occasion, without any knowledge on the part of the lady of what I was doing, I passed slowly, for about ten seconds, over the upper third of the thigh, the — pole of a strongly magnetized steel rod, four inches long by one third of an inch in diameter. The effect was surprising and alarming. The pain shifted its position, became more diffused and higher up, but was not relieved. A state of stupor intervened, her respiration was oppressed, a death-like pallor overspread her countenance, her features became contracted, her eyes sunken and half closed, the heart acted feebly, and the surface of the body was cool and covered by clammy perspiration. The depressing effect much resembled the action of morphia on the previous day, but was even greater. All these symptoms were manifested within a few minutes. After waiting about fifteen minutes, I applied the other pole, the + one, for the same length of time, to a spot a little below the hip joint, and in a short time new symptoms were manifested. The pain was apparently increased and more localized, the extremities cool, but the perspiration was checked, the breathing was deeper, the eyes closed naturally, and all the signs of depression began to vanish."

These extracts from Dr. Vansant's very interesting paper are sufficient to show the results of his researches. I come, in the next place, to detail my own observations.

Unlike Dr. Vansant, who used bar magnets, I have found the horseshoe form, such as that now exhibited, more available. It is better to have them all of one size, for then they can be bound together and the power greatly increased. The poles can be separated by so inclining the magnet as to bring one pole nearer to the surface than the other. In many cases, however, it is advisable to use both poles, a measure impracticable with bar magnets. Moreover, the bar magnet soon loses its magnetism, whereas the horshoe magnet, if the keeper be retained in its proper position, will suffer no deterioration in years of constant use. When it is advisable to act with great effect upon a very limited portion of the body, needles may be attached to one or both poles, or placed between a pair of magnets. When two or more magnets are united into a compound one, care must be taken that all the north and all the south poles correspond; otherwise the power will be greatly reduced.

I have, during the past two years, employed magnets to a considerable extent in my practice, mainly in the treatment of neuralgia, but it is only for a short time that I have used them in chorea and paralysis. It is these last classes of cases that I propose to consider in the present paper, so far as the therapeutical influence of the magnet is concerned.

CHOREA.

Case I.—A. C., aged ten, became affected with chorea, as nearly as could be ascertained, about the 5th of July of the present year. She came under my observation August 21. At that time there were jactitations of all the limbs and of the muscles of the trunk and face. She had lost the power of speech. By means of a yoke lapping over the neck and shoulders, I attached two horseshoe magnets, each capable of supporting four pounds of iron, in such a way that one rested over the cervico dorsal region of the spine, and the other over the sternum, the poles pointing downward. The magnets were applied at 1:30 P. M., on the 22d of August. At 1:55 all choreic movements had ceased. At 1:57 she spoke a few words: "Yes—no—I don't know." At 2:5 she said, "I want to go home, mamma." The magnets were then removed. Up to this date (September 15), there has been no return.

Case II.—Similar to the first, but patient could speak. Magnets produced no effect, though repeatedly applied. Patient cured with arsenic in large doses.

Case III.—J. T., a girl aged eleven, was brought to me September 1, to be treated for chorea. The case was unilateral, the movements being confined to the left side. One magnet was applied to the front of the left thigh, and the other to the cervical region of the spine. Movements ceased in eleven minutes. No relapse.

Case IV.—W. L., a boy aged seven, choreic for three weeks, movements general. No result from magnets. Cured in twelve days with arsenic.

Case V.—C. D., a boy aged nine, choreic for two months, very much debilitated, not able to walk without repeatedly falling, movements general. No result from magnets. Cured in two weeks with arsenic.

Case VI.—R. D., a girl aged nine, choreic for six weeks, movements general. No result from magnets.

Case VII.—J. L., a girl aged nine, choreic for six weeks, movements confined to face and neck. No result from magnets. Still under treatment with arsenic, improving.

Case VIII.—D. T., a boy aged eight, choreic for a month, movements general. No result from magnets, though they were repeatedly applied and left on for an hour or more at a time.

Case IX.—C. W., a boy aged seven, choreic for three months, movements confined to hands and face. No result from repeated application of magnets.

In all, I have used the magnet in nine cases of chorea. In two of them the effects were remarkable, complete cures being produced in a few minutes. In the seven others no result followed. It is probable that further observation will show that variations in the power of the magnets or the mode of application will be of advantage.

PARALYSIS FROM CEREBRAL HEMORRHAGE.

Case I.—J. R., a gentleman, an engineer by profession, and a speculator in mines, while rising from bed at about eleven o'clock on the morning of September 2, felt slight dizziness and fell to the floor, but without losing consciousness. His wife helped him to the bed. He was hemiplegic on the left side, and had lost the power of speech. I saw him at 2 P. M. He was then unable to speak, and was paralyzed on the left side, as regards both motion and sensibility. He could protrude the tongue, and it came out straight. Could swallow.

On the 7th, at 2:30 P. M., I applied a double horseshoe magnet, capable of sustaining ten pounds of iron, to the side of the body, the poles pointing upward. Just before attaching it with a strong towel I tested the sensibility of the hand and foot. No force of pinching gave rise to the slightest evidence of its being felt. He could not move a muscle of either the arm or the leg. At 2:37 I pinched the skin of the left forearm. He at once made a grimace, and reached over with the other hand to scratch the part. The skin of the face was also sensitive. At 2:40 the thigh, leg, and foot were sensitive. In fact, sensibility was restored to the whole of the paralyzed side.

I now left him, directing that the magnet should not be removed till my return. I saw him again at 5:25 the same day. He was then sitting up in bed and moving the left arm as well as he had ever done, and he could move the leg in all directions. I requested him to get up, which he did, walking across the floor without difficulty, and scarcely dragging the leg in the least. The face was still slightly paralyzed, and he could not yet speak a word. Before leaving him I fastened two small magnets, each capable of lifting half a pound of iron, one to the paralyzed side of the face, and one to the nape of the neck, the poles pointing upward, and directed that they should be left in position all night. The next morning a message came to say that he had recovered his speech.

This gentleman returned home a few days afterward, entirely recovered, so far as I could perceive, except that the left side of the face was slightly weaker than the right. On the 22d of September he had another attack, and died comatose.

Case II.—This case is that of an eminent physician of this city, who, on the morning of September 30, of the present year, became suddenly aphasic and hemiplegic. There was no loss of consciousness. I saw him at 2 P.M. of the same day, in consultation with Dr. W. H. H. Hall. The right side of the face was paralyzed, and motion was entirely lost in the right arm and leg. Cutaneous sensibility was abolished throughout the whole of the right side, as was also the sense of touch on the right side of the tongue. Patient retained the faculty of smelling, and the power of holding and passing the urine and fæces. He could not speak a word, but nodded or shook his head for yes and no. All the phenomena, as well as the previous history of the case, pointed to the existence of a clot, probably involving the left optic thalamus and the posterior third of the internal capsule. A year ago he had had a retinal hemorrhage, and for several years had suffered from cirrhosis of the kidneys. The patient was kept quiet. I saw him every day with Dr. Hall, but no medicine was administered, except a solution of bromide of sodium in infusion of digitalis (the heart was very weak) and a hypodermic injection of morphia, to which he had for several months been accustomed, at bedtime.

Yesterday, October 4, I saw the patient as usual. There were present his wife and his father, also a physician. His condition was unchanged, except that he could say "yes" and "no," and pronounce his own name after some one else. I pinched the skin of the forearm on the paralyzed side till my nails almost met through the skin, but there was no sensibility. I had taken with me a magnet, capable of sustaining about five pounds, intending to apply it as a therapeutical measure. My purpose was to place it against the left side, under the axilla, and to keep it in apposition with the surface by means of a towel passing around the body. While the towel was being got ready I laid the magnet against the paralyzed side, the poles pointing upward, in order to show his father how I designed employing it. It remained there less than three minutes, when I again quietly pinched the skin of the forearm, preparatory to applying the magnet more permanently. To my intense surprise, and that of all in the room, the patient gave a grimace, and, reaching over his body with his sound hand, took hold of the other and removed it to the opposite side of his chest. Upon examination, I found that the restoration of sensibility was thorough, and it has remained intact up to the present time. I left the magnet in contact with the body for several hours longer, but there was no further improvement.

If these cases stood alone, it might naturally be supposed that error existed somewhere, so contrary are they to our clinical experience and our ideas of the connection between the symptoms and the lesions in cerebral hemorrhages. But they are not isolated. Within the last week I have met with the report of two cases of like character occurring to MM. Debove and Boudet, and reported by the former gentleman.* In the first of these cases the patient, a man aged forty-five, was suddenly struck with an apoplectic attack. There was complete hemiplegia of sensibility on the left side, and the power of motion, though not altogether abolished, was much diminished. There was sensory hemianæsthesia—smell, taste, hearing, and sight on the left side being abolished or impaired. There was also color blindness.

Six days after the attack, when the condition was unchanged, at 6 P.M., two magnets were applied to the left side, one against the thorax and the other to the knee. At 6:30 the patient felt a severe pain in the head; at 7, the pain had disappeared; at 8, sensibility and motility had begun to reappear; at 8:30 the magnets were removed, and the patient was carefully examined. It was found that the general sensibility had returned to the whole of the previously anæsthetic region, that the patient walked easily without dragging the limb, that the strength of the left hand had increased over fivefold, that the taste, smell, hearing, and sight were entirely restored, and that the ability to distinguish colors was regained.

The other case was that of a woman, aged sixty-five, who on the 30th of March had an apoplectic seizure. Complete right hemiplegia and hemianæsthesia, from the face downward. Integrity of the special senses impaired, but not completely abolished. On April 8, at 3 P.M., a strong magnet was placed between the arm and the chest on the right side, the poles pointing toward the axilla. Ten minutes after this application the sensibility had returned to the arm, and at 3:30 it was complete over the whole of the paralyzed side. The magnet was left in its position for eighteen hours. On the 9th, the patient could walk about the room, and had begun to talk, and on the following day there was no trace of paralysis, either of motion or of sensibility, except a slight hesitation in motion.

It appears to me that in all these cases, as well as those of hysterical hemianæsthesia which have been reported as

* *Comptes Rendus*. August 31, 1874.

† "On the Physiological Action of Magnetism." By John Vansant, formerly Passed Assistant Surgeon, U. S. Navy, and late Surgeon and Brevet Lieutenant Colonel, U. S. Army: *Journal of Psychological Medicine*. New York, April, 1870, p. 264.

* Note sur deux nouveaux faits d'hémiplégie de la motilité et de la sensibilité. Guérison par une application d'aimants ("Archives de Neurologie," t. i. p. 92).

cured by the magnet and other metallic applications by Charcot and his pupils, are instances in which, if there were any organic lesion at all, this was mainly situated in the optic thalamus. It is well known that the hemianæsthesia, as well as the hemiplegia, due to lesions of this organ, is more or less transitory in character, and that the former often suddenly disappears after persisting a few days, or even hours. It would be asking too much to claim that the cures in the instances cited, whether of chorea or of paralysis, were due to any specific influence of the magnet. It is possible that the association was a mere coincidence, or that the relief was due to a strong mental impression made on the mind of the patient. At any rate, the cases are interesting as facts, and are worthy of being allowed to exert an influence in directing further inquiry. As such, they are submitted to the consideration of the Neurological Society.

THE MAGNET IN PARALYSIS.

PROFESSOR NOTHNAGEL relates (Virchow's *Archiv*, May, 1880) some experiments he made on rabbits with the Leyden jar. He found that sufficiently powerful sparks produced a localized anæsthesia of transient nature. The extent of the lesion was proportional to the density of the electrical fluid, that is, to its quantity divided by the diameter of the limb. At the same time the motor fibers were temporarily paralyzed, the duration of the paralysis being about the same as that of the loss of sensation. The faradic excitability of the paralyzed nerves was diminished. The author next describes a case where a man was struck by lightning on his right hand, which became completely paralyzed and anæsthetic, and remained so for ten weeks. The recovery was sudden and rapid; in two days the hand became quite well again, and remained so for six years, when suddenly both sensation and motion disappeared from it. Three months after this occurrence he was admitted into the hospital. He was submitted to the usual electro-therapeutic measures during a few days, but without the slightest benefit. One day, however, it occurred to Professor Nothnagel, who was then experimenting with the magnet on a case of hemi anæsthesia, to apply the latter to the paralyzed hand. His astonishment was great on finding that within three quarters of an hour sensation and motility were returning. Further applications of the magnet were followed by a complete recovery, and a few days afterwards the patient resumed his work. No transfer was observed.

EXCISION OF THE INFERIOR DENTAL NERVE FOR THE RELIEF OF OBSTINATE NEURALGIA.*

THE case before the class is one of neuralgia of the region supplied with sensation by the third division of the fifth nerve. The woman is so great a sufferer that, as life itself is concerned, there exists absolute necessity to afford her relief. To accept her own story, the pain aroused in the simple act of opening the mouth is so great that she has starved during the last nine weeks rather than endure it.

What is neuralgia? It is nothing; it is everything. The term itself signifies pain, nerve pain; that alone. To say that a person has neuralgia is to express nothing in the way of cause; an aching toe is a neuralgic toe; so, too, an aching tooth; so, also, paining heart.

In a case of neuralgia, that which the surgeon wants to get at is *cause*. To diagnose simply that a patient has neuralgia is to say nothing more expressive of the doctorly attributes than is spoken by a child when complaining of a stomachache. Without an added explanation as to cause, he who diagnoses neuralgia diagnoses nothing. Pain arises out of irritation, and diagnosis in neuralgia is appreciation of the thing that irritates.

In this hospital, where are treated so many cases of neuralgia, large opportunity is furnished for the study of cause. So much in the way of cause are we constantly exposing, so much in this way have we discovered, that naturally Anstie's views come to stand in little favor with us. Only a single week back, as you remember, I told the class about a private patient, just dismissed at the time, where the pharmacy had been exhausted in the constitutional treatment of a tic douloureux, found finally to be dependent on an ulcer situated upon the inner face of the uterine fundus. In proportion as the ulcer responded to the treatment employed for its cure so did the pain disappear. A multitude of similar instances are familiar to this clinic.

The patient before us has neuralgia from a cause. From what cause? From the presence of an irritation. Where is the irritant, and what is it?

In the press of the service to day I have no time to tell you how I arrived at a conclusion that the trouble is disorganization of a nerve, and that the part affected lies in the dental canal of the lower jaw. A matter of interest to the class, and as well of vital concern to the patient, is the correctness of the inference made.

I now proceed to expose and resect the inferior maxillary nerve. Here, gentlemen, I introduce you to a manner of performing the operation which I am sure needs only to be seen to be appreciated. The operation is one of my own devising. I show you the lady without a scar; I desire to cure her without making one. Now to the surgical indications of the case. The first is to operate without resulting disfigurement; the second, to so expose the nerve that it may be examined before being lifted; the next is the cutting of the bone in such a manner as will justify me in acting from the conclusion of no suppuration. The patient will now be etherized. . . . I now pull the skin of the neck upward upon the jaw, and thus draw up the shade line from the base of the face (right side) until it rests upon the body of the inferior maxilla; and then, feeling for the facial artery, I protect it by my finger-nail placed just in front. Inserting the blade at this point, with its heel toward my finger, I cut forward, making an incision about an inch and a half in length, parallel with the bone. Now my assistants, with the aid of retractors, pull the artery backward, and also stretch and hold the lips of the wound apart. No hurry, gentlemen; make haste slowly. I now remove a strip of the periosteum corresponding with what I judge to be the breadth of the maxillary or inferior dental canal. This is accomplished with the aid of the raspatory at the end of the scalpel. I look now for the mental foramen, which I know signifies the position of the canal. I have it.

Now I resort to the *engine*, with a fine cylinder saw attached, making at least 2,000 revolutions a minute. The machine, as a whole, is noiseless and efficient in operation. Rapidly as this little saw is revolving, I hold the hand-piece and can control it as I would a pen. The delicacy of its manipulation in experienced hands every surgeon who has ever used it must appreciate. I pass the saw from the mental foramen backward along the margin of the canal. The upper side is cut. Back again to the starting point, and soon the lower portion is divided. Now, replacing the saw with this delicate trephine, I sever the strip of bone at either extremity, and with this finely-tempered chisel pry up and remove it. Underneath should lie (normally) the vessels and the nerve, but here I have from pathological expressions diagnosed an abnormal condition and disorganization of the nerve; or it may be that an inflammatory exudate is pressing upon it, or, possibly, a foreign growth developing within the canal. I will examine. See with what ease we proceed—no anxiety, no blunder, but perfectly satisfy ourselves as to what we have or have not. I do not find anything like a nerve in the center of this canal. Gone, disorganized as well as the vessels; I was right in my diagnosis. Now, I have the end of the posterior portion of the nerve. Before exsecting it at the posterior part of the opening I will stretch it, in order to obtain whatever benefit may result from such stretching. I now divide it. The end of the anterior portion is as red as a cherry. I will cut it out also.

Now I wash and cleanse the parts, which is an important point to be observed. Again the engine. This time it carries an inverted conoidal corundum disk, with which I smooth down the roughness and points around the margins of the opening, for I do not wish to have necrosis or caries, which there might not be sufficient vitality to resist. I am careful to have no foreign material inclosed. *That* would interfere with my calculations. Finally, I bring the lips of the wound together in such manner as to leave no *bag* to give trouble. I aim to get as immediate union as possible. I have not used a single ligature. If hemorrhage *should* occur, the wound can be opened and the bleeding arrested by packing. My dressing is antiseptic and dry. Now, gentlemen, there is a nerve resected and no deformity. The indications have all been met, and I expect you to appreciate the refinement of the operation æsthetically.

(The patient was kept in the ward for two or three days and then sent home. Two weeks afterward her physician sent word that she was relieved of pain and doing exceedingly well.)—*Medical Record.*

* A clinical lecture by James E. Garretson, M.D., Professor of Anatomy and Surgery in the Philadelphia Dental College.

SYPHILIS AND MODERN SOCIETY.

IT happened to the writer to be recently called to see a man of most respectable surroundings, who bore an unmistakable venereal sore upon his lip, and subsequently manifested all the features of secondary syphilis. It was said that this had followed a trifling surgical operation upon the part affected for the removal of a slight deformity; the instruments or hands of the surgeon communicating the specific virus in the same manner, it will be remembered, that a New York dentist, not long ago, communicated syphilis by his forceps; and a well-known laryngologist inoculated a number of patients with pharyngeal chancre. Whether the explanation given by the patient above referred to was correct or not in this special case, it will serve as a text for offering to our readers a few pertinent remarks upon syphilis that must claim the thoughtful consideration of every one whose look is forward; if they do not fill him with apprehension for the future of his race.

There is prevailing among us a disease as inoculable as smallpox, as disgusting as leprosy, as malignant as cancer. Unfortunately, it is comparatively slow in its operation, and its victims have time to marry and to be given in marriage, flattering themselves, perchance, that the destroyer has loosened his deadly grasp; thrice unfortunately, they are enabled by the friendly aid of the physician to propagate their physically depraved kind, victims of congenital syphilis, imbibing poison with their mother's milk. These syphilides, by inoculation or by inheritance, form a considerable, and, we believe, an increasing proportion of the community in every large American city, as every physician can attest. There are secrets connected with many prominent families that are known only to the family physician. We note, in passing, that the great decline of the use of humanized lymph in vaccination, by careful physicians, is due simply to the fact that no one can guarantee any given crust to be entirely above the suspicion of syphilis. This dreadful disease, once contracted, impresses itself so fully upon the system as to be practically ineradicable; once infected, it follows the man to his grave. Besides the common mode of contamination by impure intercourse, syphilis may be communicated by surgical and other instruments; by borrowed pipes and cigars; by car-drivers' whistles; by toys sold to children upon the street by venders with poisoned lips or fingers; by drinking cups or towels in railway stations; by public urinals and water closets; by hired bathing robes; by putting money or pins in the mouth, and in a thousand other ways that are familiar to medical men. Every practicing physician has seen cases in which syphilis was thus innocently acquired, communicated by a Judas kiss, or inflicted upon a physician in the honorable pursuit of his calling!

If the results are as stated, and the means of communication so easily and so completely beset us, is there no special obligation resting upon those to whom these facts are known and appreciated, to rouse the community to a sense of the magnitude of this danger? Medical men alone realize the terrible ravages of syphilis; does not this knowledge bring to them a perculiar measure of responsibility?

Owing to the facilities offered in our cities, it is known that a certain number of thousands of young men about town will contract syphilis this year, just as many thousands did last year, and the year before; which may be looked upon as the legitimate harvest of certain evils that are permitted to exist among us. To these may be added the comparatively small number who acquire the disease accidentally, or by exceptional methods, and a total is reached that, by those who know what it involves, is not at all pleasing to contemplate. The question of syphilis interests not only the sanitarian and physician, but also every thinking man, who loves his country, and hopes for the perpetuity of its institutions.

The natives of the Sandwich Islands are being exterminated by this disease. The Anglo-Saxon constitution is stronger, but what hopes can be entertained for American society when it becomes equally permeated by this pest, as it appears to be rapidly doing? What is the remedy? Licensing houses of prostitution? A thousand times, No! Never let it be said that American morals and American manhood have sunk so low that houses of ill fame have become a necessary evil. On the contrary, we call upon every honorable soul, who would scorn to subject the sister of another to a fate from which he would defend his own with the last drop of his blood; every law-abiding and upright mind, who respects the rights of his fellow-man; every filial heart who loves his mother and reveres her sex; every respecter of virtue, morals, and good government, TO KNOW NO LAW FOR PROSTITUTION.

Inasmuch as some, whose opinions upon other subjects we respect, have advocated the licensing of prostitution as offering in their minds the only method of regulating this terrible evil and reducing the number of its victims, we would urge that, in place of this (as we regard it) unfortunate plan, some such method as the following be attentively considered with a view to its ultimate adoption as a part of the integral law of each State of the Union.

The crude plan here outlined involves the *free* treatment of all cases of venereal disease by medical officers designated by the State; consultations, however, to be strictly confidential, except that prostitutes shall be immediately sent to lock hospitals to remain until free from symptoms of disease. These special sanitary officers should be paid for their services from a special fund derived *not from the licensing of houses of prostitution*, but from fines collected as follows: Upon the complaint of a man, supported by oath, that he was inoculated with venereal disease by a certain woman, the said woman shall be arrested and sent to a hospital for examination. If the accusation is found to be true, she shall pay a fine of not less than twenty-five dollars into the State treasury, and be detained in the hospital until well. Moreover, the keeper of the house, in which the disease was acquired, shall be made to pay a fine of not less than one hundred dollars, or undergo three months' imprisonment in the county jail; and furthermore, the owner of the house or property in which said inoculation occurred shall be fined not less than two hundred dollars, which shall be a lien upon the property until duly discharged according to law.

It seems to us as if this plan has the merit of feasibility, without running contrary to the fundamental principles of morality and the teachings of religion. We beg the medical press to agitate this great question until some effectual means are adopted for crushing out, or in some measure reducing to control, this bane of modern society.—*The College and Clinical Record.*

HEADACHES AND THEIR TREATMENT.

DR. F. A. SIMMONS, of St. Joseph, Mo., writes, in the St. Joseph *Medical and Surgical Reporter*, for October, 1880:

This disagreeable and common affection is associated with so many dissimilar conditions, and originates from such a variety of causes—immediate and remote—that its pathology and treatment are more unsatisfactory, perhaps, than any subject in the whole range of medical practice. In England, when all other causes fail to account for an attack it is called *gouty*. In America, it is *sick* and *bilious*—occasionally *rheumatic*—but never gouty. These terms greatly influence the ideas the profession have of the pathology of the disease and their plans of its treatment. It should not be considered as a disease of itself, but should be regarded as a painful expression of encephalic change, a symptom—associated, it may be, with various organic lesions—with hyperæmia, anæmia, hyperæsthenia, or with hyperacute sensibility to all impressions, especially those of a reflex nature, originating in causes connected with the bladder, uterus, disorders of the stomach or other organs, or those reflected from other distant parts. A knowledge of these conditions has a great practical bearing in the treatment of headache. The remedies suitable for one form may aggravate that of another variety. There is no safe, reliable, universal panacea; no one drug that will cure all these conditions. The search should not be for specifics, unless in pathological culture and physiological research. The specific condition should be ascertained, and then the specific drug selected to alleviate the pain of that condition.

The headache of hyperæmia is associated with a determination of blood to the brain, and a fullness of its vessels. There is pressure exerted by it upon the dura mater and pia mater; and these membranes being acutely sensitive, pain is produced, with a feeling of constriction. There is heat of the head, redness of the face, throbbing of the carotids, fullness and force of the pulse, ringing in the ears, vertigo, congestion of the conjunctiva, contracted pupil, and in severe cases nausea and vomiting. As recumbency facilitates the afflux of blood to the brain, it generally increases the pain.

Relief may be sought by depletion, purgatives, cold applications to the head, ice water, ice bags, chloral hydrate in xx. grain doses, bromide of potassium in xx. to xl. grain doses, and by ergota in teaspoonful doses of the fluid extract.

Those reduced by acute disease, by hemorrhages, leucorrhœa, prolonged lactation, malaria, and those affected with leukæmia, tuberculosis, and chlorosis, have *anæmic headache.*

It is recognized by the history above given, by a slow,

languid pulse, dilated pupils, cool surface, pale face, and by a look of weariness and depression.

The treatment requires quietude of body and mind, stimulating and anodyne remedies, ammonia, camphor, opiates, ext. guarana—3 ss. to 3 j.; spirits—brandy, whisky, etc., during the attack; and iron, strychnia, quinia, arsenic, bathing, electricity, and nourishing diet to tone up the system during the interval.

In the hyperæsthetic headache we have excitement and a pecular sensitiveness of the brain, that render it painfully cognizant of impressions that ordinarily would not affect it at all, as we have spasms and convulsions from slight noises—as the rattling of water - in similar conditions of motorial irritation, caused by brain poisoning from strychnia, hydrophobia, and other poisonous agents. The accumulation of *urea* in the system produces this irritable, painful neurotic condition of the brain so favorable to headache. Some of the most severe and persistent headaches I ever saw were associated with Bright's disease of the kidneys. Other poisonous agents also affect it thus. This painful predisposition and impressibility is sometimes left by sunstroke. Sometimes it is the legacy of inheritance. Come as it may, or however produced, when this painful predisposition exists, slight exciting causes from without or from within are sufficient to develop an attack.

Mental and bodily fatigue, exposure to the sun's rays, loss of sleep, imprudence in diet, the excessive use of tea, coffee, tobacco, and spirits, may be mentioned as familiar examples. The irritations reflected from distant parts and organs, as those of the uterus, bladder, and stomach, have been mentioned. This neurotic condition of the brain may be more or less present in all the varieties of headache. It may be associated with anæmia or with hyperæmia.

In the treatment, opium or its alkaloids, morphia or codeia, when not contraindicated by some individul idiosyncrasy, is the surest and speediest remedy we possess to alleviate the attack. Hydrate of chloral in fifteen grain doses, repeated every hour or two till relief is obtained, is a valuable remedy, especially where there is some hyperæmia. So, in the same condition are the bromides, in full doses, caffeine, in two to five grain doses, in tea or coffee, fluid extract of guarana (*Paullinia sorbilis*) in one-half to one drachm doses, are pleasant and good remedies.

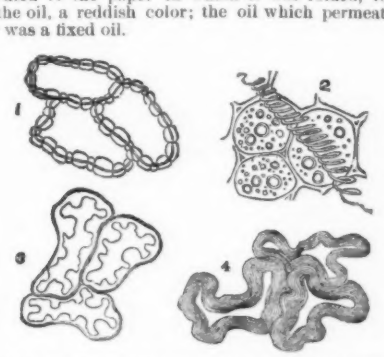
To prevent a return of an attack the system should be toned up during the interval and put in as perfect a state of health as is possible. In most cases tonics are indicated. Other organs should be carefully interrogated for sources of reflex excitability.

A SAMPLE OF CAYENNE.*

By THOMAS GREENISH, F.C.S.

A SHORT time since a sample of Cayenne was placed in my hands by Mr. Holmes with a request that I would submit it to microscopial examination. It had been sent to him as an article which had recently made its appearance in commerce.

The sample possessed all the external characters of the true Cayenne, and such a one as is grown in Natal, ground in the colony, and sent in that state to this country. It had an oily appearance which seemed artificial, and communicated to the paper in which it was folded, together with the oil, a reddish color; the oil which permeated the paper was a fixed oil.



CHARACTERISTIC CELLS OF THE CAPSICUM FRUIT.

There are two distinct Cayennes grown in Natal, one is a brilliant red, and the other yellowish and corresponding to the Nepaul pepper; they are both, and more especially the former, extremely pungent. This sample, however, although possessing, to the naked eye, all the external characters of the Natal red pepper was entirely devoid of pungency.

At first it was thought probable that some other pod than that of the capsicum had been ground and forwarded to this country for the purpose of adulterating the genuine article; to determine this point with certainty, a portion of it was subjected to careful histological examination, and the cellular structure compared with that of true Natal samples which I had previously examined.

The annexed drawing shows the characteristic cells of the capsicum fruit, isolated, and mounted separately for the purpose of reference on such an occasion as the present, where they were required for comparison with those of the sample The cells, Fig. 1, are the external cells of the capsicum pod; usually they possess more or less of a beaded appearance as represented in the drawing. Within them are parenchymatous cells, Fig. 2, traversed by spiral vessels. The surface of the internal coat is covered by the cells, Fig. 3. The irregularities seen on the internal surface of individual cells and so conspicuous in Fig. 1 and 3, as compared with the parenchymatous cells (Fig. 2), are caused by the irregular deposition of the secondary matter, assuming very different and interesting forms, a circumstance frequently observed in histological investigation.

With the pod must necessarily be ground the seed which it contains, and hence is met with in an examination of the powder a remarkably characteristic cell, serpentine in form, and with its secondary deposit in regular laminæ (Fig. 4), which are rendered conspicuous by the appropriate reagents.

Having given considerable attention to the anatomical examinations of different capsicums, without meeting with one that was not more or less pungent, the question arose, how has this sample been deprived of its pungency, so as still to retain its color?

In the first place, heat was employed to drive off the acrid principles of the capsicum, but this was not successful; decomposition occurred just when volatilization was taking place; this may possibly have been due to the fact that the pungent principle resides in a resin as well as a volatile oil. Diluted spirit was then tried and by this agent the acrid matter was removed without or with very little loss of color, leaving a marc devoid of pungency, and possessing much the appearance of the sample in question.

From subsequent information it is believed that the more brilliant samples of Cayenne, but deprived of pungency, or perhaps a by-product of some manufacture, are used for giving the special plumage to canaries, and that the sample in question was most probably one intended for this purpose, and not an adulterant of commercial Cayenne.

The investigation of this subject has afforded me the opportunity of describing the structural details of the capsicum fruit, and will probably be accepted as another illustration of the value of histological investigation in determining, by anatomical detail, the true from the false in materia medica specimens or any product of the vegetable kingdom which may be submitted to the pharmacist.

* From a paper read before the British Pharmaceutical Conference.

BIOLOGY AND MICROSCOPY.

AT the meeting, November 1, 1880, of the Biological and Microscopical Section of the Academy of Natural Sciences, Philadelphia, Dr. Carl Seiler in the chair,

Dr. J. Gibbons Hunt, in referring to a communication made some time ago, said the announcement then made by him that ciliated epithelia covered the intestines of vertebrated animals was received with considerable doubt by some of the members of the section. Since then a German journal contained a similar statement, which also fully verified his observations.

CARMINE HAIR.

Dr. Hunt presented for examination some hairs taken from the head of an aged lady which were of a beautiful carmine color. They were short hairs growing underneath the gray and covered the entire head. They presented no pathological condition. The color is permanent and of a uniform carmine tint. Under the microscope there was no other abnormal appearance.

MICROSCOPICAL IMPROVEMENTS.

Dr. Hunt, chairman of the committee appointed to prepare a report upon the exhibits and improvements in microscopical science at the fifteenth annual exhibition of the section, held October 15, 1880, read the following paper:

The committee appointed at the last meeting of the section to report matters of interest brought forward at the fifteenth annual meeting of the "Microscopical and Biological Section" of the Academy of Natural Sciences, beg leave to offer the following report:

The hall of the Academy was comfortably filled with, perhaps, 2,000 visitors, who were distributed all over the building, the museum being opened and lighted for the fuller entertainment of our guests. The entomological section contributed to our success by generously displaying a portion of their magnificent collection of butterflies, moths, and beetles; insects of most gorgeous color, and forms so curious and rare that they will be remembered by many for a long time to come.

Without seeking ungenerously to depreciate other scientific organizations by unduly exalting the Academy, we say that no other scientific society in our city ever had within its walls such an assembly of interested and intelligent citizens as was in the Academy on that occasion.

On firm tables arranged for the purpose one hundred and twenty-seven microscopes were in position, displaying objects ranging through many classes of the mineral, vegetable, and animal kingdoms, and illuminated in nearly all approved ways. Of this number of microscopes, Zentmayer made 48, Beck 30, Crouch 23, Bausch & Lomb 7, Queen & Co. 5, Hartnack 2, Lidle & Poalk 2, Gundlack 1, Ross 1, J. C. Green 1, J. H. Steward 1, unknown 6.

Your committee can look back to the beginning of microscopy in Philadelphia, and at that time, and for a long period after, Nachet's microscopes were the only ones—with few exceptions—then in use. Now those inferior French instruments are not reported at our meetings.

It would be neither profitable nor interesting to report all the commoner objects shown at the meeting, not because such exhibits have not equal educational value with rarer things, but for the reason that they have been mentioned on previous occasions and in the reports of similar meetings elsewhere. We will ask attention, therefore, to such objects only as best mark the progress of microscopy at this time.

Many preparations of animal tissues, human and comparative, were shown; such as injected lung, kidney, brain, skin, etc., and some were stained with carmine, then bathed in acid and mounted in balsam, *secundum artem ohmletum;* and all such looked about as well as could be expected.

Best experience, however, is becoming convinced that it is no longer good work to stain *only* the bioplasts, and to fill the vessels with gelatine colored with carmine, and mounted in balsam. Around every bioplast so treated is the cell-body, larger or smaller, which remains invisible. Moreover, growing and finest vessels cannot be structurally demonstrated in that way, neither can the connecting tissues which bind all other parts together be demonstrated or studied by these old processes.

Such work has no longer any significance in the entire and correct interpretation of the tissues, but it does create abnormal stomata, and apocryphal perivascular spaces to be found only in the books. These relics of a *past* era in microscopy should now be placed carefully away in the back drawers of histological cabinets, thence to be dug out like strange fossils by coming generations of microscopists.

The time has come to move forward by doing better work in which more tissue elements shall be demonstrated. Some recent sections, double stained, by Cole & Son, of London, were shown at the meeting, and they revealed more tissue elements than any other balsam mounts yet seen this side of the Atlantic.

The division of cartilage cells during change towards bone—the so-called osteoblasts—medullary cells and fat cells, all with bioplasts showing division and vacuolation; not nebulously and doubtfully, but sharply differentiated under 500°, with the binocular, could be seen, educating us more fully into a better understanding of such things. We welcome such advanced work, regardless whence it comes. A beautiful slide of the young bot fly (*Æstrus gasterophilus*), attached to a hair from the horse, is worthy of report.

Living polyps (*Pectenatella magnifica*), and the new rotifer (*Apocia emilia*), intermediate between Lascinularia and Melicerta, are reported, as well chosen illustrations of uncommon pond life.

In exhibits of plant tissues, by double staining, we saw nothing new. Indeed, truth compels the acknowledgment that nearly all we saw were fatally spoiled by bad work. There is something in plant tissues besides cell walls, no matter what form they take. Is it still necessary to remove all secondary deposits and bioplasts from the cells before a section is fit for study? We think not. After evisceration by bleaching solutions, plant sections are unfit for scientific study. Yet this fossiliferous work is still shown as something very fine. Put *it, too,* away on the back shelves for the micro-paleontologist; if well balsamed it will keep.

A new species (*Cribraria dictydioides*) from our park is reported on exhibition. Good slides of *Microsporon furfur*, probably the cause of *Tinea versicolor* of the skin, and of *Achorion schonleinii*, an alleged cause of *Tinea favosa*, or ringworm, both difficult to obtain and preserve, are reported.

We note a marked advance in the preservation of delicate fungi, and of fresh-water algæ. Many of these slides retained the natural form and color almost unchanged, and all such were preserved in camphor water one ounce and glycerine about six drops.

Wickersheimer's fluid is totally unfit for such work. A few marine algæ mounted in balsam obtained our sympathetic commiseration that these beautiful "weeds of the sea" should be so viciously treated. No intelligible traces were left of the living things. May our eyes never be asked to witness such relics again. Put all marine algæ in Goadby's solution, and many will be preserved unchanged.

Many beautiful polarizing objects were well shown; and the Camden Society contributed nice work in this line. Æsculine and naphthaline were among the most beautiful, but it is an error to exhibit these thin crystals under the binocular with the *second* eye-pieces, because such displays give bad definition.

Among miscellaneous objects we report slides of young oysters *in motion;* sections of nummulitic limestone, from which the pyramids were built; diatoms covered with iron sulphuret; butterfly scales arranged in beautiful bouquets; micrographs, and the electric spark as developed between two pencil points. In turning from this part of our report we suggest the possibility of improvement in the manner of showing some objects. Expertness in microscopic display is best learned—and perhaps learned only—by *much* practice in the resolution of difficult test objects, because in such work greatest attention to illumination and adjustment of lenses is essential, and when that experience is once thus acquired it influences, for best results, all other displays.

We observed many binocular microscopes badly illuminated without achromatic condensers or an equivalent. This is an error. It is not possible to get best results with the binocular without a condenser below the stage. In all microscopic works command superabundant light; it is easy to moderate it to suit special wants.

In microscopes some improvements and novelties may be reported for the past year. A small folding microscope, standing very firmly when in use, costing fifteen dollars—exhibited by Queen & Co.—is worthy of report.

All of Crouch's instruments on exhibition, except his largest stand, turn down beyond the horizontal, thus giving great facility for the eye-piece to slip out, and also for observing the stars, advantages not useful in *this* country. His binocular prisms slip entirely out, instead of being checked in proper position by a stop. The fine adjustment is still retained on the end of the body.

Beck has removed the flat foot, of whatever shape, from all of his instruments, and they all stand on three toes and are therefore steady. His new "international" stand, which was exhibited, presents some improvements of interest. The stage is 6½ inches in diameter, and has ¾ of an inch lateral motion, and nearly that in vertical direction. Motion is given by a screw and rack opposed by springs, which are claimed to obviate loss of motion—a great improvement over his former stages. The stage rotates around the optical axis; and also around its own axis by means of a milled-head pinion, enabling it to be completely inverted, and a graduated circle registers the degrees as it goes round. All the illuminating apparatus, if desired, swings around a center level with the stage. The obliquity of illumination is registered on a large graduated circle, which is movable up and down, carrying with it all illuminating apparatus. To fix the body in any position a lever handled-clamp is attached to one trunnion. The fine adjustment is retained on the end of the body. If the microscope can be claimed as an instrument of supreme precision, it is wrong to place the fine adjustment on the body. Every time it is moved the magnifying power of the instrument is changed, and an error is introduced, and the microscope is just that much *not* an instrument of precision. Means have been found to remedy that defect, and all possible sources of error should be eliminated from the microscopes of the future, just as soon as means are found to do it.

Another large instrument made by Beck, having a stage motion of four inches in either direction, is reported. The binocular body is carried at the end of a long horizontal bar. As in some other microscopes the body may be detached when the instrument can be used for dissection. The plan of carrying the body on a horizontal bar is a retrograde step in the construction of microscopes. Only for special purposes such plan has been abandoned by most makers, because steadiness cannot be secured except by great massiveness or by some compensating contrivance.

Zentmayer's improved "Centennial" stand was shown at our meeting. Its new mechanical stage, five inches in diameter, is claimed as the thinnest yet made. Light 70° oblique is admitted beneath it. Milled heads move it vertically 1⅛ inches, and laterally 1¼ inches. It may be inverted, if desired, retaining still the object in the center of rotation of the sub-stage. This point is realized by an ingenious eccentric fitting, which carries the stage and does not interfere with greatest stability. The centering of the sub-stage is effected by means compact and ridiculously simple. The plan of swinging the sub-stage is well known and not capable of improvement. It is the most simple plan yet devised for that purpose. The fine adjustment moves the entire body without changing its length. The finish and workmanship, and the motions of this instrument place it in precision, simplicity, and excellence far ahead of all other microscopes at our meeting. Since this microscope appeared at our Centennial Exhibition for the first time, many skillful makers have aimed to receive some of its advantages by ingenious mechanical devices, but none yet have approached its classical simplicity and fewness of parts. This instrument marked a new departure in the construction of microscopes, and without injustice your committee can say no less.

We report two lamps attached to microscopes in place of the mirrors. One was an ordinary Beck's lamp fitted with a carrier for the purpose. It has facilities for centering in all directions. The other, made by Zentmayer, was three

inches high—including chimney of blue glass—and about 1¾ inches wide. It could be adjusted without rack in every direction, gives out no perceptible heat of a hot night, and will burn without refilling for six hours. With Wenham's modified binocular prism it gives superabundant light in both fields, with a twentieth objective. With an ordinary prism it fills equally well both fields with all lenses up to a fifth. It requires only a slight addition to the ordinary condenser to make it very desirable. It is elegantly made. We desire to express gratification and appreciation for the company of our friends from West Chester, Camden, and from Harrisburg, and to acknowledge the additional interest which they gave to the meeting.

In concluding our report your committee would suggest that inasmuch as these annual meetings are strictly social and scientific, and are given at great responsibility and expense, in order for our own better education and to awaken among our intelligent citizens a love for the beautiful things which the microscope can reveal, such meetings be kept entirely clear from all attempts to placard into notoriety either private members or officers of the society.

R. S. KENDERDINE,
J. G. HUNT,
T. W. STARR.

THE DETECTION OF FORGERIES BY THE MICROSCOPE.*

AN article in the *Banker's Magazine* for August, 1878, refers to the value of the compound microscope in the examination of handwriting, beyond the ordinary methods of experts who rely upon unaided vision or a hand-lens. It shows that the conclusions of an ordinary expert are reliable just so far as they rest upon data which can be explained, and no farther. A man who writes his signature frequently falls into a series of rhythmical movements which are peculiar to himself. This may arise from habit, or individuality of muscular organization. His general handwriting may differ in style from his signature, but the accentuation remains the same. A talented imitator may produce this general rhythm of a signature, and cause the testimony of an expert to become vague and uncertain. The expert may detect a difference, empirically, but he is unable to explain it to the satisfaction of a jury. "It is just at this point," says the writer, quoting from a letter to the New York *Times*, "where the methods of the expert break down, that the more delicate methods of optical analysis represented by the compound microscope interpose to detect and demonstrate forgery." In addition to the larger rhythm upon which the expert bases his judgment, there is a minute secondary rhythm caused by the action of the small muscles in regulating the amount of pressure upon the pen, which is imperceptible to the naked eye, and cannot be accurately determined with a simple magnifier, but which is easily discerned in a compound instrument under a power of about ten diameters, if the writing is strongly illuminated with a good bull's-eye condensing lens. These variations of pressure are between 200 and 300 to the inch, and are as regular in proportion, as they are spontaneous and involuntary. When a man writes naturally, the pressure variations are rhythmical, while on the contrary, when he is consciously imitating the writing of another, they are irregular and unsymmetrical, no matter how cleverly a signature may be imitated. So long as the writer exercises the voluntary control of the hand, which is essential to the act of imitation, just so long the margin of the stroke can be demonstrated optically to be irregular in the length and the distribution of the waves which indicate the muscular impulses. Thus the compound microscope determines the issue at the point where the coarser processes of the ordinary expert fail. My attention having been called to this subject, I instituted numerous experiments, which have convinced me of the general accuracy of the article, of which the foregoing is an abridgment. Careful investigation enables me to classify the phenomena of handwriting, especially signatures, as analyzed by the compound microscope, as follows:

1. The rhythm of form, dependent on habit or individual organization. This is the main dependence of the ordinary expert. It may be determined by the naked eye or a hand-lens, but is still more easily seen by means of the magnified image in the compound microscope. In some cases, an enlarged photograph of genuine and disputed signatures may be useful—remembering, however, that the form of letters may change, from time to time, more readily than the general rhythm.

2. The rhythm of progress. This is the involuntary rhythm, referred to above as pressure variations on the point of the pen, and seen as a wavy margin to the letters of signature when well illuminated on the stage of the compound microscope. It is caused, in all probability, by the rapidly successive nerve impulses upon which the contraction of the muscles depend. In age or infirmity, these impulses are perceptible to the eye, and we say that the hand trembles. "But as a matter of microscopic analysis the hand always trembles, and it is an inalienable property of muscular contraction that it should." The regularity of this rhythm is destroyed by a voluntary effort at imitation, and is somewhat interfered with, but not entirely broken, by mental excitement. This rhythm differs in different handwritings, so that it is well for the examiner, if practicable, to accustom himself to the habitual rhythm of a genuine signature before expressing a judgment on one which is questioned.

The art of writing is a most complicated one, requiring the consentaneous action of many muscles. When perfectly performed it should be nearly, if not quite, automatic, requiring very little mental stimulus for its performance. If any act which should be automatic demands our attention in order to execute it, the difficulty of performance increases. The ordinary mental stimulus suffers an emotional diversion, which causes proportional muscular impotence. Hence emotional disturbance causes a trembling handwriting. In cases of writer's cramp, in which the muscles respond but sluggishly to the will, and render the grasp of the pen faltering and uncertain, this rhythm is greatly exaggerated or interrupted. Paralysis of the ulnar nerve, rheumatism of the shoulder or wrist, neuralgia and alcoholism, may also interfere with the rhythm of progress. But in no case is the failure of the rhythm so marked as in a voluntary attempt at imitation.

3. The rhythm of pressure. By this I mean, not the involuntary and rapid action of the muscles, producing a microscopic wave as the writing progresses, but a rhythmical alternation of light and dark strokes, which is characteristic of some signatures, and which, in all probability, is a variety of the rhythm of form; yet, as it is revealed to microscopic analysis rather than to ordinary vision, it may escape the most expert imitator, and so become another factor in making up a judgment in any case.

If the microscopist carefully observes these three rhythms, being careful of the illumination of the letters, he cannot fail to demonstrate the difference between a genuine and an imitated signature.

In a recent trial before Judge Crane, in Oakland, I was able to discriminate between imitated and genuine signatures in a large number of cases of remarkable similarity, prepared by a most talented writer, as well as to testify to the genuineness of signatures in which there was considerable variation of form. Mr. George C. Hickox, also a member of the Microscopical Society, and well known as an expert in such matters, when his attention was called to this use of the compound microscope, declared to the Court that it was a new and wonderful revelation, fixing beyond question the individuality of handwriting especially of signatures.

Should this method of investigation be much used, as it ought to be, it would be convenient to have a microscope made for the purpose, having a large stage with clips so as to hold paper of considerable width, a tube of wide diameter to collect as much light as possible, a very low power eye-piece, and a special objective of long focus and large field of view.

*A paper read by Prof. J. H. Wythe, A.M., M.D., before the San Francisco Microscopical Society.

THE ATMOSPHERE OF CELESTIAL BODIES.

By M. JOSÉ J. LANDEUR.

THE height of the terrestrial atmosphere is a problem yet to be solved. For a long time it was admitted that this height did not exceed ten leagues. Then came Liais and Schiapparelli, who assigned to it respectively 200 and 400 *kilometres* (about 124 and 248 miles). Finally, very recently, M. Ritter, basing his calculations upon the considerations drawn from the mechanical theory of heat, obtained 350 *kilometres* (about 217 miles).

What causes these differences? So far as the first two are concerned, the reason may be found in the fact that the observations upon which their conclusions are based can give only uncertain results, since they relate to optical phenomena taking place in a bank of air sufficiently dense to have them easily appreciable. Now nothing prevents that beyond the bank of air thus manifested the atmosphere should continue to unsupposed heights. As to the third, deduced from the observation of shooting-stars, I shall show further along that the manner in which M. Schiapparelli and the greater number of other astronomers draw conclusions from the facts is open to objections.

First, in calculating the height of the limit of the air, let R represent the radius of the earth; T, the daily rotation expressed in seconds; g, the force of gravitation; d, the distance at which the force of attraction and the centrifugal force are equal; z, the intensity of either of these forces; we then have on one hand,

$$z = \frac{g\,R^2}{d^2}$$

and on the other,

$$z = \frac{4\pi^2 d^2}{T^2}$$

whence, carrying out all the operations,

$$\log d = \tfrac{1}{3}(\log g + 2\log R + 2\log T - 1{\cdot}596360).$$

Making the numerical application to the letters, g, R. and T. we have

$$d = 36{,}096 \textit{ kilometres} \text{ (or, 22,429 miles).}$$

It must be concluded from this result that a mass of highly rarefied air extends far beyond the bank wherein are visible the last twilight gleams. As to the form of this envelope it is evident that it must be that of a lens whose poles must coincide, or nearly coincide, with the poles of the appreciable atmosphere. A like reason leads to the belief that this rarefied atmosphere has a spheroidal form, although much less marked than that of the heavier air; which fact accounts for the observations in Brazil giving a much greater height for the appreciable atmosphere than that deduced from observations made in Europe.

It should be remarked that, in order to calculate the height of the outer envelope of air, there need only be considered the force of attraction and the centrifugal force. If one takes note of the nature of this envelope, it is easy to see that, in quitting a state of equilibrium, the molecules are set at liberty, and consequently become at once free to obey the expansive forces that are inherent in them. It is by this chain of reasoning that we are led to suppose that, beyond the bank of appreciable air there must exist matter in the state of extreme rarefaction, extending to the distance at which the forces of the gaseous molecules are counterbalanced by the action of gravitation, or, in other words, to a considerable distance.

In order to get an idea of this state of matter we may conceive that it exists there in conditions similar enough to those of the radiant state, where there is no reason to doubt that the inherent forces of the gas manifest themselves freely. Now, if this be so, it need not be expected, at least for the moment, to demonstrate by speculative reasoning alone the enormous distance to which this ultra gaseous state of matter extends, the properties of this matter not being well enough known to permit us to attack it from this point of view. We must, therefore, have recourse solely to observation; but what kind of observation can enlighten us on this subject?

I will begin by calling attention to this, that the explanation of the meteoric showers belonging to the same group, which is attributed to the *radiant*, is not compatible with the height of the meteors, which is not (according to all observers) greater at the utmost than 460 *kilometres* (about 285 miles); for from this conclusion it would result that the shooting stars proceed, not from a circumscribed region but from all points of the celestial vault; it would then be a sort of star-shower, invading every part of the firmament. The more the radiant defines its limits closely and the more its position in the heavens is independent of that of the observer on the globe, the greater must be its distance; now observation shows that, for all the periodic showers, the region whence the meteors come is not only circumscribed enough but its position is the same for all observers, no matter what may be their situation in the hemisphere turned toward the phenomena. It follows, consequently, that these bodies burst into flame far beyond 460 *kilometres* (285 miles), the furthest limit that has been assigned to them at the moment of becoming visible.

Let us imagine two observers situated at a distance apart equal to a radius of the earth, or, what is the same thing, one person making observations at nine or ten hours of interval in a night of November. Let us admit that the uncertainty that the two observers have in fixing exactly the radiating point amounts to 5°, which is very reasonable; this admitted, and placing one's self under the most favorable conditions, that is, supposing the two uncertainties to be opposed to each other, let us designate the radius of the earth by R, and the distance of the radiant by D, and we shall have:

$$D = R \text{ cotang } 5°,$$

hence,

$$D = 72{,}800 \textit{ kilometres} \text{ [about 45,243 miles].}$$

If one takes into account the gaseous mass which the meteoric body must traverse—at first with a velocity but little greater than its own, then faster and faster—*before* becoming incandescent, it will easily be understood that the figure I have just given is even below the reality, and that we must, in consequence, place the limit of the traces of the atmosphere in its ultra-gaseous state at a height which cannot be less than from fourteen to sixteen terrestrial radii.

Nevertheless, there may be made one serious objection to this theory; it is that we must admit the existence of extraordinary velocities. But why should we draw back in face of the facts? Besides, there is nothing unlikely in such a velocity, since it concerns bodies which become incandescent in an extremely rarefied locality. Now, in order that these phenomena should take place, the immensity of the velocity is a necessary factor, whether we attribute the incandescence produced to the friction of the molecules, or to the heat set free by the compression of the air, according to Regnault's idea, or to both causes combined.

If these deductions are correct we may be allowed to apply them to other celestial bodies which, like the earth, have a perceptible gaseous atmosphere. Let us try to so apply it, beginning with the sun, which will show certain coincidences most interesting from more than one point of view.

The height of the sun's atmosphere, having regard to the attraction and the centrifugal force, is, according to the formula,

$$d = 75 \text{ solar radii.}$$

It is starting from this distance that the solar matter in its ultra-gaseous state extends under the form of lenticular nebulosity, giving rise to the zodiacal light. It ought to shine in part with a light borrowed from the sun, since the materials of which it is originally composed having been as heterogeneous as those of the photosphere and chromosphere whence it came, it must be that some of its elements should combine together, creating heavier compounds, which gradually cool off, and from which the solar light is reflected. The rest of the matter, more homogeneous, is principally composed of hydrogen, for it is nothing but the continuation of the extreme limits of the chromosphere and the corona, where (with the exception of helium and one other element whose existence is revealed by a green line) the predominating element is hydrogen. But it must also shine with its own light. It is loudly claimed on one hand that this matter shines when it is traversed by an electric current; on the other hand, that the sun is the origin of all the manifestations of physical forces, manifestations whose order of grandeur exceeds all that we know by our means of observation, and whose traces we find even to the farthest distant regions.

It is thus that we can reconcile two results which have hitherto appeared contradictory. According to some, the zodiacal light is in part polarized in a plane passing through the sun, and its spectrum is continuous; this is only a consequence of the solid corpuscles of which I have just spoken, whatever may be their nature. According to others, and according to my own observations, the spectrum of the zodiacal light) contains a diffused greenish blue band, which is in accord with the existence of a highly dilated gas shining with its own light. Other observers have concluded that this spectrum was the same as that of the aurora borealis. It should be further added that the spectrum of the aurora contains also the cannellated lines of nitrogen.

The time is come to note a curious coincidence. It is well known that the researches made by Père Decheyrens, under the clear sky of Zi-ka-Wei, place it beyond doubt that the zodiacal nebulosity extends beyond the terrestrial orbit by a very appreciable distance. The earth travels wholly within it from the month of September until the beginning of May. It is, above all, in the winter months and in April or May that its extent beyond the earth's orbit is the greatest. From this fact, I conclude that the ultra gaseous atmosphere of our globe, in traversing this nebulosity, absorbs its elements up to a certain point, whence it results that the terrestrial envelope must contain zodiacal elements, mingled with those coming exclusively from the rarefied air; this is evident at least during the interval during which the earth is within the nebulosity. Admitting this, and remembering that the poles of the terrestrial globe are also the source of manifestations—more or less restrained without doubt, but none the less visible—of electric or magnetic forces, we are in a position to understand why the auroras furnish the above-mentioned results to the spectral analysis.

From all that has been said, results another consequence important enough. No one can fail to know how insufficient are the diverse hypotheses hitherto proposed to explain the secular acceleration of the mean movement of the moon, the calculations accounting for only one-half the observed acceleration. Now, the theory of the zodiacal nebulosity leads to quite a different explanation, one which appears to me very reasonable, for nothing is more natural than to attribute this acceleration to the resistance the moon meets when it plunges into the zodiacal region. Let us suppose that the pressure in this region is only seventy-six one-hundred thousandths of a *millimetre* (about three one-hundred-thousandths of an inch), or, in other words, about equal to that contained in Crookes' tubes; and adopt the figures obtained by Mr. Le Dantec in his experiments upon the resistance of the air; then taking count of the mass and volume of the moon, I have been able to calculate how much the tangential impulse of our satellite must be retarded by reason of the resistance in this region, and, consequently, what should be the acceleration of the moon's mean movement.

The number of seconds, according to my calculation, appreciably exceeds the slight acceleration of six seconds a century, which are to be explained. Although my results are only approximate, since the given quantities, such as M. Le Dantec's figures, are only approximate, we are on the right road, and it is in the fact that the density of the zodiacal nebulosity is below one-millionth of an atmosphere, and in the new order of ideas which I have just formulated, that the efficient cause of the acceleration of the moon's mean movement must be sought.

JUPITER'S SATELLITES.

AT the last meeting of the California Academy of Sciences a communication was read from Professor George Davidson, President of the Academy, on the "Visibility of Jupiter's Satellites to the Naked Eye." He says: The seeing of Jupiter's satellites with the unassisted eye is so rare an occurrence, that I wish to place upon record a recent unmistakable case. From the Station Monticello, of the United States Coast and Geodetic Survey, 3,125 feet above the sea, we overlook Berryessa Valley on the west and the Sacramento Valley on the east. The station is on the highest point of a sharp ridge, trending generally north and south, with many deep gulches on either side. For nearly a month the Sacramento and Coast Range Valleys have been filled with dense smoke, and the distant mountain ranges have all been hidden. Even the bold, dark, grand mass of Mt. Helena, distant but 24 miles, was barely visible through the thick atmosphere. The upper limit of the smoke stratum was quite sharply defined to the eastward; above it the sky was generally clear, but upon the present occasion only moderately so. The weather for some time had been warm and pleasant, without clouds or wind. On the early evening of Monday, September 20, we were looking at the obscured moon struggling through the dense smoke. Jupiter, at an estimated elevation of about 8 degrees, was emerging from it, and for an elevation of 25 to 30 degrees the whole sky was hazy, and stars of the fifth magnitude, and even some of the larger ones, were not visible to the naked eye. There was not the least radiation to Jupiter, and the planet rose through the smoky but quiet atmosphere into the thinner smoke or haze without radiant points of light to blur his appearance.

With the unassisted eye Professor Davidson detected the third satellite of Jupiter, to the left and below the disk of the planet; but, lest he might be mistaken, he refrained from calling attention to it for some minutes, until there could be no possible mistake, when he announced the visibility of a satellite, but without stating its position in relation to the primary. All the officers immediately announced its visibility and position, but naturally wondered why it should be seen so unmistakably through such a thick, hazy atmosphere. A binocular, or good field glass, with magnifying power of seven diameters, revealed it, and also showed the other satellites on the side of the planet, but revealing the first and second satellites with difficulty, until the planet had risen somewhat higher. The third satellite continued visible to the naked eye for perhaps twenty minutes, when the moon rose above the smoke stratum, and the planet began to exhibit traces of radiation, when the satellite was lost to the naked eye, although all the satellites had become much brighter than before in the field of binocular. Upon subsequent nights, after the smoke had in great measure been blown away, with a remarkably clear sky and no moon, but with great radiation to the planet, no satellites have been surely made out with the unassisted vision. The observers who distinctly saw the satellites were Messrs. Lawson, Gilbert, and Buckland, and also Mrs. Davidson. I have before reported one or more cases of my seeing a satellite of Jupiter, notably once on Mount Diablo, in 1876.

THE ANTIQUITY OF MAN IN EASTERN AMERICA, GEOLOGICALLY CONSIDERED.*

By HENRY CARVILL LEWIS, A.M.

IN the course of an investigation of the surface geology of Southeast Pennsylvania, the writer has determined some facts, regarding one of the gravels, which, bearing directly upon the antiquity of man in America, become of interest. In former papers the writer has shown that the gravels of the Delaware Valley belong to several distinct ages; and if, therefore, at any place, the remains of man are shown to occur, it will be important to know to which of these gravels they should be referred.

The surface formations of Southeast Pennsylvania may be divided into five clays and four gravels. These are, beginning with the oldest: (1) *Jurasso-cretaceous* plastic clay, seen at Turkey Hill, Bucks Co.; (2) Tertiary clays of the "*Brandon Period*," associated with the iron ore, kaolin, and lignite of the Montgomery County Valley; (3) "*Bryn Mawr gravel*," often found at elevations of four hundred feet, characterized by the presence of an iron conglomerate and of pebbles of Potsdam, but never of Triassic rocks, and conjectured to be late Tertiary; (4) "*Branchtown clay*" of similar age; (5) "*Glassboro' gravel*," of latest Pliocene age, found also on the watershed in New Jersey, between the Atlantic and the Delaware, and known by its pebbles of Niagara limestone and of other fossiliferous rocks; (6) "*Philadelphia red gravel*," of Champlain age, which contains numerous bowlders of all materials, fragments of Triassic rocks, etc., which shows flow and plunge structures and wave action on a large scale, which rests on a decomposed gneiss, and which is confined to the river valley; (7) *Philadelphia brick clay*, which, with its bowlders, rests upon the last, and, like it, appears to have been deposited by the waters of the melting northern glacier; (8) "*Trenton gravel*," a sandy river gravel forming the bed of the Delaware; (9) the modern *alluvial mud* now forming in the tidewater swamps.

Of these formations, one of the least conspicuous at Philadelphia is that now called the Trenton gravel. It is a true river gravel, rising here but a few feet above the water, and forming a quicksand when below water level. It is of gray color, and contains pebbles composed entirely of the rocks which form the upper valley of the river. Unlike older gravels, it has very few quartz pebbles, and its pebbles are generally flat. In the middle of the river at Philadelphia it is one hundred feet deep. On tracing this gravel up the Delaware it is found to rise higher above the river and to extend farther back from it as we proceed up stream. Thus, at Bristol it extends two miles back from the river, and is bounded by a well marked hill, upon which rest the older gravels. At Trenton, the limit of tidewater, the narrow upland portion of the valley begins, and from there up this gravel is shallow, and confined to the river bed. The oceanic gravels trend across New Jersey, and are no more seen. Two surface formations alone remain—the river gravel of post-glacial age, and the brick clay, with its bowlders, of Champlain age. The first lies within the last, and both can be traced up to the great terminal moraine near Belvidere. It is to be especially noted that the Trenton gravel is newer than a drift of Champlain age. It is in this Trenton gravel, and in this gravel alone, that traces of man are found.

The Trenton gravel at the locality which gives it its name is remarkably well exposed. Trenton is at the point where a long narrow valley with continuous downward slope opens out into a wide alluvial plain, and where the rocky floor of the river suddenly descends below ocean level. It is here that the bulk of a gravel, swept down the upper valley, would, on meeting tidewater, stop in its course, and with its bowlders be heaped up in a mass, immediately afterward to be cut through by the river. It was thus that a cliff of gravel fifty feet high was here formed, the river having cut through the gravel instead of flowing upon it, as at Philadelphia. This explanation dispenses with the necessity of assuming, as some geologists have done, the submergence of the land by the ocean at the time of the deposition of the gravel. That Southern New Jersey was at that time dry land is shown by the fact that this gravel at Trenton extends inland a few miles only, and, having filled up a bar in the ancient flooded river, is bounded by hills of the older gravel which forms Southern New Jersey.

There are many facts indicating that the Trenton gravel is a true river gravel and not a glacial moraine, which are detailed in the present paper. The absence of glacial marks on the rocks, the stratified character of the gravel, the topography of its banks, the comparative amount of its erosion, and the character of its materials, all point to the conclusion that it was deposited by a great flood of the river; and this, when taken in connection with the fact that it lies within a channel cut through gravel deposited by the waters of the melting glacier, indicates a post-glacial and comparatively recent age of the Trenton gravel.

The important bearing of this fact upon the antiquity of man on the Delaware, which, as will appear, depends directly upon the age of this gravel, is here apparent. Calculations based upon the erosive power of running water show that the time necessary for the river to cut through this gravel down to the rock need not have been long. On the other hand no such flood as deposited this gravel has ever occurred within the historical epoch. No such large bowlders are ever now carried down the river. No modern rainstorms could cause such a flood. It is difficult to assign any other cause than that of a melting glacier. Yet such a glacier could hardly be the great Northern glacier, for these gravels are much newer than those of the Champlain epoch. There is here evidence of a second and more recent glacier in the Delaware Valley.

The hypothesis of a *second glacial epoch* seems to explain all the facts observed. A similar period in Europe—the Reindeer period—is supported by many facts. Should such a period not be traced in America, the date of the melting glacier must be made much more recent than that generally assigned.

The relics of man which occur in the Trenton gravel, and which were first found by Dr. C. C. Abbott, are of great interest. In shape, in size, in workmanship, and in material the implements here found are quite different from those used by the Red Indian. These "paleoliths" are embedded at various depths in undisturbed Trenton gravel. There are two points which offer strong evidence that they are as old as the gravel. The first is the fact that modern Indian implements ("neoliths"), although abundant on the surface, never occur more than a few inches below it, and are never associated with the paleoliths, which are found at depths of from five to forty feet below the surface. This fact alone argues a different age for the two classes of implements. The second fact is that, when found below the surface, the paleoliths always occur in the Trenton gravel and never in older gravels. The writer has gone over, with Dr. Abbott, much of the ground where the implements occur, and it was very interesting to find that it was only within the limits of the Trenton gravel, previously traced out by the writer, that Dr. Abbott had found implements below the surface. Here, then, is the strongest probability, even if the implements were found on the surface only, that they belonged to and were of coeval deposition with the river gravel.

The implements found in the river gravels of Europe are of similar type, though, as a rule, perhaps less rude. It is of interest to find that very similar implements have been used by the Esquimaux, and it is probable that that race, now living in a climate and under conditions perhaps similar to those once existing in the Delaware, may have some kinship with the pre-Indian people of this river. The occurrence of bones of Arctic animals in the Trenton gravel indicates a period of cold.

All the evidence now gathered points to the fact that at the time of the Trenton gravel flood, man, in a rude state, lived upon the ancient banks of the Delaware. If future archæological work can show a connection between this people and the Esquimaux, it may be appropriate to call the period of the Trenton gravel and of this paleolithic people—a period perhaps following a second glacial age—the *Esquimau period*, a name more suggestive, and derived from a higher order of beings than that which gave the name "Reindeer Period."

While others have held that the occurrence of implements in the Trenton gravel indicates the existence of man in inter-glacial or even pre-glacial times, the writer believes that the investigations here described indicate the origin of man at a time which, geologically considered, is recent. Neither in the Champlain deposits, in the moraine material of the north, or in any other gravels have undoubted traces of man been discovered.

The actual age of the Trenton gravel, and the consequent antiquity of man in the Delaware, cannot be determined by geological data alone. It is the aim of this paper to define man's antiquity in relation to geological rather than to historical events. If, in showing that the Esquimau period is the last of the geological ages, it does not necessarily follow that it is by any means recent; it must be remembered, on the other hand, that its high antiquity is not proven by the facts thus far observed.

The conclusions to which the facts seem to point are briefly summarized as follows:

1. That the Trenton gravel, the only gravel in which implements occur, is a true river deposit of post-glacial age, and the most recent of all the gravels of the Delaware Valley.

2. That the paleoliths found in it really belong to and are a part of the gravel, and that they indicate the existence of man in a rude state at a time when the flooded river flowed on top of this gravel.

3. That the data obtained does not necessarily prove, geologically considered, a vast antiquity of man in Eastern America.

* Read before the A. A. A. S., Boston, 1880.

A NEW 10-inch equatorial, with an object-glass by Merz, has been presented to the Geneva Observatory by its Director, Prof. Emil Plantamour. It is to be devoted to observations of the major planets and their satellites, of parallax of stars, and of double stars, with occasional observations of minor planets.

THE TOOTHED BIRDS OF KANSAS.*

WEST from the valley of the Mississippi the stratified formations which underlie the prairie region spread over thousands of square miles nearly as horizontal as when they were deposited. Here and there they have been ridged up into anticlines, now deeply trenched by denuding agents, or have had wedges of the ancient Archæan rocks thrust through them, along the flanks of which their upturned beds can be examined in detail. Hence in spite of their prevalent flatness opportunities are afforded for tracing their stratigraphical succession from top to bottom. They reach a maximum of thickness of from seven or eight miles. Yet throughout this vast depth of strata the unconformabilities seem to be nearly all of local and unimportant character. The several geological systems follow each other continuously, and generally in such a sequence of insensible gradation as to show that geological history in that part of the globe was marked by comparatively few great and destructive geographical revolutions. The record of this history remains in an almost unbroken series of strata from the Primordial zones up into the older Tertiary formations.

Here surely if anywhere in the world there should be a tolerably ample chronicle of the sequence of living creatures, so far at least as regards marine forms. If the intermediate types, so much desired by the evolutionist, are ever to be found embedded in the rocks of the earth's crust, surely here we may expect to find them. An area of continuous tranquil deposit, and of slow subsidence, unaffected for almost the whole of geological time by serious upheaval, metamorphism, or unconformability, containing within itself a well-nigh unbroken record of geological changes—a very promised land for the paleontologist! Hardly more than a dozen years have passed since this great region began to be systematically searched for organic remains. Yet during that brief period what treasures have come from its teeming strata! New orders of Vertebrates, some of them of extraordinary types, have thence been added to the long roll of organic forms. Other orders, scantily developed in Europe, and previously but little known, have been ascertained to have teemed in these far western plains. Whether we regard the prodigious number of individual specimens, and the great variety of genera and species, or the marvelously perfect state of preservation in which the remains occur, there is no other known area where facilities for paleontological research of the most minute and thorough kind exist so abundantly.

Thanks to the labors, first of the universally honored Joseph Leidy, and then of his younger successors, Marsh and Cope, the first fruits of that rich paleontological harvest have already been gathered. In the Yale College Museum alone about 1,0 0 new species of extinct Vertebrates have been received from the West during the past twelve years, at least one-half of which remain to be investigated. Mr. Cope's museum at Philadelphia is likewise crowded with new forms. If such results have been achieved merely by expeditions equipped for at most but a few months of such labor as is possible at present in these wilds, what may not be looked for when some of the habitable portions of the fossiliferous regions come to be searched, when quarries, railway cuttings, and other artificial openings add to the opportunities of exploring the rocks, and when systematic fossil-hunting can be carried on from a near center of supplies, instead of from a base several thousand miles away in the Eastern States!

Among the organic wonders of which from time to time during the past decade announcements have appeared, none having been received with more interest than the discovery of birds with teeth, made by Professor Marsh near the end of the year 1870, in the middle Cretaceous rocks, which in Kansas and Colorado spread out eastward from the base of the Rocky Mountains. The more striking features of this remarkable transitional ornithic type were described by Mr. Marsh as far back as 1872, and are now tolerably familiar to naturalists from his writings and to geologists from the descriptions and restorations which have appeared in scientific journals and text-books. But its detailed structure has only now been made known in the splendid monograph on Odontornithes which has just appeared. This work is intended to form volume vii. of the Geological Exploration of the 40th Parallel, carried out by Mr. Clarence King for the Engineer Department, and also to stand as the first of a series of memoirs of the Peabody Museum of Yale College. As a fitting termination to the noble Survey series of quartos, and as a splendid forerunner for what we hope will prove a long and illustrious series of memoirs from Yale, the volume is doubly welcome. The splendor of paper, printing, drawing, and engraving (and in the advanced copy with which we have been favored, the sumptuousness of binding) that have been lavished on the work bespeak preliminary acknowledgment.

So perfect a matrix do the peculiar buff, chalky, or marly beds of the Kansas middle Cretaceous formations furnish for the preservation of organic remains, that almost every bone of the skeletons of some of the birds has been recovered. The materials for the study of their osteology is thus almost as ample as that for any living bird. Full advantage of this abundant store of material has been taken. The cases and cellars in the Peabody Museum at New Haven contain the remains of about fifty different individuals of a single bird. Every bone of its skeleton, with the exception of one or two terminal toe bones and the extreme point of the tail, has been recovered, and is here carefully drawn of the natural size. Never before has it been possible, we believe, to reconstruct so perfectly so ancient an organism.

The volume is divided into two parts. In the first of these the detailed structure is given of the bird on which the author has bestowed the name of *Hesperornis*. The skeleton of this animal if extended to its full length would measure about six feet from the point of the bill to the end of the tail. It must have been a typical aquatic bird, without any power of flight, but with strongly developed limbs and a long flexible neck, whereby it was doubtless endowed with remarkable powers of diving and swimming, and of seizing the abundant fishes of the shallow seas in which it lived. Compared with our modern birds, the two features of this ancient form which most forcibly arrest attention are the teeth and the legs. The teeth were covered with smooth enamel, terminating upward in conical pointed crowns and downward in stout fangs closely resembling those of mosasauroid reptiles. Their mode of growth and replacement have been determined to have taken place in a manner very similar to that in some reptiles, the young tooth forming on the inner side of the fang of the tooth in use, and increasing in size, while a pit for its reception was gradually made by

* "Odontornithes; a Monograph on the Extinct Toothed Birds of North America." By Prof. O. C. Marsh, Yale College. Vol. I. of Memoirs of the Peabody Museum of Yale College, New Haven, Conn., and Vol. VII. of the Geological Exploration of the 40th Parallel.

absorption. The old tooth, being progressively undermined, was finally expelled by its successor, the number of teeth thus remaining unchanged. The teeth were implanted in a common alveolar groove, as in *Ichthyosaurus*. In the upper jaw they were confined to the maxillary and entirely absent from the pre-maxillary bone; in the lower jaw they extended from near the anterior extremity of the ramus along the entire upper border of the dentary bone. Mr. Marsh believes that they were held in position by cartilage which permitted some fore and aft movement, but on the decay of which after death the teeth readily became displaced and fell out of the jaw.

This is an important fact in its bearing upon the nature of the teeth found on the same slab of Solenhofen limestone with the well known *Archæopteryx*. These teeth, it will be remembered, were referred by Mr. Evans to the bird itself—a reference fully confirmed by Mr. Marsh, who says that he at once identified the teeth as those of birds and not of fishes, and by the subsequent discovery of other remains of the bird. In *Hesperornis regalis* there appear to have been fourteen functional teeth in the maxillary bone and thirty-three teeth in the corresponding ramus of the lower jaw. The wings are rudimentary or aborted, a remnant of the humerus alone existing. They may have gradually diminished from disuse until, as the power of flight ceased, the legs and feet increased in proportion, and assumed the massive dimensions shown in the specimens, or, as Mr. Marsh suggests, the bird may have been a carnivorous aquatic ostrich, never having possessed the power of flight, but descended from a reptilian ancestry which is strongly recalled by different portions of the skeleton. Among recent birds, the peculiar legs and feet of *Hesperornis* find their nearest analogues in the Grebes of the genus *Podiceps*. They were admirably adapted for propulsion in water, but scarcely served for walking on land. Locomotion must have been entirely performed by the posterior limbs—a peculiarity which distinguishes *Hesperornis* from all other birds recent or fossil. The tail appears to have been composed of twelve vertebræ, unique in their peculiar widely extended transverse processes and depressed horizontal plowshare bone. Broad and flat, somewhat like that of the beaver, it must have been a powerful instrument in steering the bird through the water.

The second part is devoted to a description of the remains which have been found of birds belonging to a second order of Odontornithes, termed *Odontotormæ*. Unlike *Hesperornis*, they seem to have been all of comparatively small size and to have possessed powerful wings, but very small legs and feet. From that contemporaneous form, and from all other known birds recent and fossil, they are distinguished by certain types of structure which point back to a very lowly ancestry, lower even than the reptile. Their bones, being mostly air filled, would enable the carcasses to float on water until, by decay or the rapacity of other animals they were separated and dispersed. Hence skeletons of these flying birds are less entire than those of the massive boned *Hesperornis*. Nevertheless the remains of no fewer than seventy-seven different individuals have been disinterred. These are included in two well marked genera, *Ichthyornis* and *Apatornis*, and were all small birds, reminding us by their strong wings and delicate legs and feet of the Terns, like which they were probably also aquatic in habit. Besides the reptilian skull and teeth, the birds of this second order were marked by the character of their vertebræ, which in their biconcave structure recall those of fishes. This is the more remarkable, as in *Hesperornis* the vertebræ are like those of modern birds. Yet these two utterly dissimilar types were contemporaries, and their remains have been preserved in the same strata. Mr. Marsh points out that the transition between the two vertebral types may be traced even in the skeleton of *Ichthyornis* itself, where the third cervical vertebra presents a modification in which the ordinary avian saddle-shaped form appears as it were in the act of development from the biconcave ichthyic form.

In a concluding chapter the author briefly touches upon some of the broader biological questions suggested by the structure of the animals described in the volume. The striking differences between the three orders into which Prof. Marsh divides toothed birds—*Archæopteryx*, *Hesperornis*, and *Ichthyornis*—serve to indicate the high antiquity of the class, and to encourage the search for ornithic remains in the earlier Secondary, if not in the later Paleozoic, rocks. The peculiar character of each of the orders Prof. Marsh believes to have been united in some earlier type, of which no trace has yet been found. This ancestral type may have been almost as much a reptile as a bird. The earliest birds were doubtless closely related to the Dinosaurs and Pterodactyls.

Of the plates, thirty-four in number, which accompany and adorn the monograph it is impossible to speak in terms of too great praise. They are strictly and rigidly scientific diagrams, wherein every bone and part of a bone is made to stand out so clearly that it would not be difficult to mould a good model of the skeleton from the plates alone. And yet with this faithfulness to the chief aim of the illustrations there is combined an artistic finish which has made each plate a kind of finished picture. We heartily congratulate the genial Professor of Paleontology at Yale on the advent of this truly imperial volume. May it be the earnest of many more from the rich store of materials which he has so courageously and enthusiastically gathered among the wilds of the far West!—*Nature*.

THE SCREW WORM.

By A. R. KILPATRICK, M.D., Grimes Co., Texas.

IN the same mail I herewith send you specimens of half-grown screw worms taken from the root of a hog's ear. The hog had been bitten by a dog on the ear a few days before, and the worms had nearly destroyed the ear of the hog when its condition was discovered; carbolized oil was applied to the sore, which caused the worms to move to the surface so they could be taken out with forceps. While the worms are in the burrow they constantly eject, or discharge, bloody water, which runs from the sore, and this discharge is very often the first intimation, or sign, of their presence. While they are sucking and not disturbed, or sickened, or disabled by any poison or insecticide, it is very difficult to dislodge them, as they hold on to the flesh with great tenacity, and as there are usually great numbers of them tightly embedded in a hole.

These worms have been more numerous, more troublesome, and more destructive this year than usual. All the newspapers of Texas have reported their ravages in stock, and among people, in all parts of the State. In Arkansas, Mississippi, and Louisiana, they are more numerous and destructive in years of overflow, and it is generally understood here that they are more numerous in wet years; and this has been an unusually rainy summer and fall.

They infested the slaughter pens and meat-stalls of the markets, and deposited their larvæ on the meat, and the larvæ would instantly pierce the meat and conceal themselves, eat, grow, and flourish. People refused to buy market-meat during the time of their prevalence. I tried to get some butchers to bring me the screw worm flies, but they would not do it, as they thought, no doubt, such a thing would injure their credit as butchers and diminish the sale of their meat. I regret that I failed to get a fly for you.

I herewith send slips clipped from newspapers in some counties in different parts of the State showing the ravages of the screw worm, on people, and, of course, there were dozens of other instances which escaped the pencil of the country editors.

They were decidedly more numerous and pestiferous from the middle of September to the present time (9th Oct.) than they were earlier in the season. Frost always stops or destroys them.

Recently a lady of Collin County was out picking cotton, when a peculiar fly bit her on the nose. It was ascertained a few days afterward that screw worms had formed and made their way under the eye to the brain. Physicians were summoned, who administered calomel. Two hundred worms were extracted, and the lady is recovering.

CONCHO COUNTY.—*Times:* Screw worms are unusually bad this season. Dr. Laton recently extracted over two hundred from the nose and head of a Mexican boy. Thanks to the doctor's skill, the boy recovered.

A HORRIBLE DEATH.—Dallas, September 24.—An unknown man, supposed to be a German named Weijgleb, was found off the railroad in a vacant shanty, near Groesbeck, nearly lifeless and horribly afflicted with screw worms in the hands, feet, and root of the spine. He had been lying in the shanty thirteen days without food or drink. Notwithstanding all efforts to save his life, he died soon after his discovery. He had on his person a pocket knife, one dollar in money, a watch chain, and a locket containing two beautiful women, which he said were his sisters, and a certificate from a pawn shop in Dallas bearing the above name.

MASON COUNTY.—Some ten days ago, Katie, the ten-year old daughter of Thos. Mahoney, residing on Peters' prairie, was taken seriously ill, and, after a few days, was brought to town and placed under the medical charge of Dr. Grandstaff, who, on examination, discovered that she had been attacked in the nose and mouth by screw worms, caused, it is supposed, by bleeding at the nose. There were a great many of the worms, and the sufferings of the little victim were almost intolerable. Dr. G. succeeded in removing over 250 worms from the nose and throat, and although still suffering somewhat from fever, it is believed that Katie will soon recover.

One of the most important discoveries incidental to the work of the U. S. Entomological Commission which we have made during the year is that pyrethrum may be successfully employed against this pest also. Prof. J. P. Stelle, one of the agents of the Commission, thus writes from San Marcos, Texas:

I have just made a discovery that cannot be otherwise than of vast importance to Texas: pyrethrum is a never-failing remedy for the notorious screw worm. The application is made by simply dusting a little of the dry powder over the sore; the worm being an air breather, soon takes in the effect and dies.

Up to this time the remedies for screw worm in Texas have been either arsenic or calomel. The former always leaves a serious sore, while the latter often does the same thing, and when applied to young calves always produces salivation. Pyrethrum leaves no unpleasant effects.—*American Entomologist*.

FIRE BLIGHT ON FRUIT TREES.

AT the late Detroit meeting of the American Society of Microscopists, a paper was read by Professor T. J. Burrill, Professor of Botany and Horticulture at the Illinois State University, upon "The So-called Fire Blight of the Pear and Twig Blight of the Apple Tree." His remarks, bearing as they do upon a subject of great practical interest, are given at some length in the *Journal of Microscopy:*

He said the widespread and disastrous disease of the pear tree called fire blight, and that no less prevalent and alarming one known as twig blight of the apple tree, are due to the same immediate agency. They are identical in origin, and as similar in their pathological characteristics as a priori reasoning might have indicated. The quince, and probably other plants, among which may be named the butternut, the Lombardy poplar, and the American aspen, also suffer from the same disease. From descriptions it was very probable that the yellows in the peach will be found due to a similar cause. The immediate and exciting cause is a living organism producing butyric fermentation in the carbonaceous compounds, starch, etc., in the cells of the affected plants, especially in those of the bark outside of the liber. This organism, if really specifically distinct, is closely allied to the butyric vibrion of Pasteur, and the Bacillus amylobacter of Van Tieghem. The disease has been known in this country over 100 years. Various theories have been advanced and one by one disproved except the one of fungus growth. In 1878 the writer announced to the Illinois Horticultural Society the discovery of bacteria apparently connected with the disease. His investigations were carried on in an orchard where there were 94 apple trees, 20 pear trees and one quince. "After finding myriads of bacteria in the fluids of the diseased tissues," he said, "I inoculated several pears and apple trees with what to me at the time were unsatisfactory but not uninstructive results. Beginning on the first day of July, 1880, I experimented in various ways at different times upon 66 trees of the pear, apple, and quince. Of the numerous applications of the virus upon the unbroken bark or leaves, none were successful. Of the inoculations there were successful 63 per cent. of the pear, 30 per cent. of the apple, and 100 per cent. of the quince. Upon the pears and quince trees used for the experiments the disease appeared only in a single case, except as the direct result of the inoculation. This latter was sometimes performed with a knife, sometimes with a needle, always with careful precautions and close subsequent examination. Such experimental limbs as permitted it were cut and preserved like herbarium specimens, and are exhibited with the paper."

The organism found answers fairly to the description of Pasteur's butyric vibrion. They are usually oblong, rounded at the ends, mostly connected two together. Their motions are not rapid, consisting of turning in every direction, and sliding irregularly forward. They are found within closed cells, in the open spaces, and in immense numbers in the viscid exudations from the diseased bark and leaves. The most conspicuous alteration observed in the tissues is the disappearance of the starch grains from the cells. The cell walls are left intact, and the protoplasmic portions remain until after the starch is mostly absorbed, and appears to suffer little change until death ensues. The disease is, *par excellence*, one of the bark. The leaves die in consequence of this, or are themselves invaded, either primarily or secondarily, by the destroyer. The progress of the disease is always slow, but the leaves of an affected limb often turn black quite suddenly, perhaps according to meteorologic conditions. In diseased bark, before change visible from without has taken place, and while the leaves are still green and fresh, an active fermentation occurs. This continues until desiccation or the exhaustion of the fermentable substances puts an end to the process. The products of this fermentation are carbon dioxide and butyric acid or a closely similar substance. From the fact that virus from the pear affects the apple tree, and *vice versa* the speaker argued that the disease was similar in each. The experiments tended to show that the virus is harmless upon the epidermis of healthy plants, nor does it penetrate through the breathing pores. The simple puncture of the bark of a tree with a needle which had been dipped in the virus would be sufficient to cause its death. Professor Burrill exhibited a small vial containing about a teaspoonful of the virus in solution, which he said was sufficient to destroy a whole orchard.

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